

**BUREAU OF HIGHWAYS  
REQUEST FOR PROPOSAL  
for  
LOW BID SERVICES**

The Michigan Department of Transportation (MDOT) is seeking professional services for the project contained in the attached scope of services.

If your firm is interested in providing services, please indicate your interest by submitting a proposal. The proposal must be submitted in accordance with the format and process outlined in the latest "Vendor Selection Guidelines for Service Contracts", available on the MDOT website. The vendor firm must provide six (6) paper copies of the proposal to the MDOT project manager named in the attached scope of services. These copies must be received by the project manager by May 5, 2006 at 12:00 p.m. (noon). Fax and electronic copies are not acceptable.

Project Manager: Michele Mueller  
Michigan Department of Transportation  
18101 W Nine Mile Road  
Southfield, MI 48075

One unbound copy of the proposal must also be submitted to Operations Contract Support at the address listed below.

A bid sheet(s) (attached) must be submitted in accordance with the attached "Guideline for Completing a Low Bid Sheet(s)" for the services you would be providing and must be submitted, separate from the proposal, directly to **Secretary, Operations Contract Support, Bureau of Highways**. The bid sheet(s) must be submitted in a sealed manila envelop, clearly marked in large red letters "**SEALED BID – TO BE OPENED ONLY BY KATHY POPOFF.**" The vendor's name and return address **MUST** be on the front of the envelope. Failure to comply with this procedure may result in your bid being opened erroneously by the mail room. **Please send the bid sheet(s) to:**

Regular Mail:

Secretary, Operations Contract Support  
Michigan Department of Transportation  
P.O. Box 30050  
Lansing, MI 48909

OR

Overnight Mail:

Secretary, Operations Contract Support  
Michigan Department of Transportation

425 W. Ottawa  
Lansing, MI 48933

Any questions relative to the scope of services must be submitted by e-mail to the MDOT project manager. Any questions must be asked at least three working days prior to the due date and time specified above. All questions and their answers will be placed on the MDOT website as soon as possible after receipt of the questions. The names of vendors submitting questions will not be disclosed.

The selection team will review the proposal submitted and post the date of the bid opening on the MDOT website. The notification will be posted at least two business days prior to the bid opening. Only bids from vendors that meet proposal requirements will be opened. The vendor with the lowest bid will be selected. The selected vendor may be contacted to confirm capacity.

**The maximum allowable pages for the proposal are limited to the selected Tier shown on MDOT Form 5100B, which is posted with this RFP. Page limits apply to the entire proposal. The number of pages per section is the decision of the creator of the proposal. Include in proposal only those items that are checked by the MDOT project manager on form 5100B.**

MDOT is an equal opportunity employer and MDOT DBE firms are encouraged to apply. The participating DBE firm, as currently certified by MDOT's Office of Equal Opportunity, shall be listed in the Proposal.

The payment method for this contract will be lump sum with milestones. A schedule is being developed and will be posted by April 14, 2006, as an addendum to this RFP.

## **INTEGRATOR SCORING POINT** **ASSIGNMENT**

### **Understanding of Services.**

- 50pts: Full understanding of scope of services above expectations.
- 30pts: Full understanding of scope of services adequate expectations.
- 10pts: Missing key aspects of scope of services.

### **Qualifications of Team.**

- 50pts: Task leaders show minimum of three (3) directly related service projects for transportation integration specifically.
- 30pts: Task leaders show minimum of one to two (1-2) directly related service projects for transportation integration specifically.
- 10pts: Task leaders show multiple network integration service projects.

### **Project Manager.**

- 50pts: Designated relevant experience in three (3) or more projects in transportation integration specifically.
- 30pts: Designated relevant experience in one to two (1-2) projects in transportation integration specifically and additional network integration projects.
- 10pts: No transportation integration specifically but two (2) or more network integration projects.

### **Quality Assurance/Quality Control.**

- 15pts: Selected QA/QC plan shows key processes and procedures unique to integration.
- 10pts: Selected QA/QC plan shows key processes and procedures not unique to integration.
- 5pts: Generic QA/QC plan.

**Equipment and Devices.**

- 50pts: All equipment and devices as noted in Table 3 of the Scope of Services meet functional specifications in Scope of Services. Appropriate specification sheets/cut sheets are supplied with appropriate designations.
- 25pts: All equipment and devices as noted in Table 3 of the Scope of Services meet functional specifications in Scope of Services. Specification sheets/cut sheets do not meet requirements specified in Scope of Services.
- 1pt: No equipment shown meets functional requirements.

**Past Performance.**

- 35pts: Designated five (5) or more successfully completed projects with a minimum value of \$1 million dollars per project, in transportation integration projects specifically for team.\*\*
- 25pts: Designated three to four (3-4) successfully completed projects with a minimum value of \$1 million dollars per project, in transportation integration and additional network integration projects for team.\*\*
- 10pts: Designated one to two (1-2) successfully completed projects with a minimum value of \$1 million dollars per project, in transportation integration and additional network integration projects for team.\*\*
- \*\* Successfully completed projects will be defined through reference checks by review team.

Job Number/Control Section:  
Description (if no IN/CS):

## Score Sheet

The selection team will complete one consensus score sheet. This score sheet will be used to score proposals. **This is not to be used for low bid.**

**Black Shading = Not Required**

**Gray Shading = Optional**

**White = Required**

\*\*\*\* ALL VENDORS MUST BE SCORED \*\*\*\*

Selection Criteria	Vendor Name:	Total Possible		Rater's Score	
	Vendor does not appear to have any conflicts of interest concerning this service. Vendor has met DBE goal or has approved waiver.	Tier II	Tier III	Tier II	Tier III
<b>Understanding of Service.</b> Describe understanding of the service to be proposed. This information is to be based on the scope of services.	Comments:		50		
<b>Qualifications of Team.</b> Provide organization chart, if required. Describe the structure of the project team including the roles of all designated key personnel and sub-vendors. For each sub-vendor, describe role in service and include what percent of the named role that the sub-vendor is expected to provide. Provide resumes for each of the key staff of the prime and sub-vendors stated above.	Comments:		50		
<b>Project Manager.</b> Take into consideration similar projects completed in both scope and size. Include project listings with contact information.	Comments:		50		
<b>Quality Assurance/Quality Control Process.</b> Provide outline plan which designates key processes and procedures that are unique to an integration project.	Comments:		15		
<b>Equipment and Devices.</b> Describe equipment and devices that will be utilized on project to meet criteria in scope of services. Specification sheets/cut sheets shall be supplied for all equipment and devices. Each specification/cut sheet is limited to two pages and must include model designation to be supplied for project.	Comments:		50		
<b>Past Performance.</b> Take into consideration similar projects completed in both scope and size. Include project listing with contact information.	Comments:		35		
		<b>Maximum Grand Total</b>		250	
Selection Team Names	Selection Team Members Signatures	Date			

## **REQUEST FOR PROPOSALS**

### **ITS SYSTEM PROCUREMENT, INSTALLATION, INTEGRATION, TESTING AND WARRANTY**

#### **MICHIGAN DOT ITS AND FREEWAY MANAGEMENT SYSTEM FOR I-94, I-69, I-96, COMMUNICATIONS HUB UPGRADE, MITSC & BLUE WATER BRIDGE OPERATIONS ROOM**

#### **I. PURPOSE**

This document describes scope of work, INTEGRATOR qualifications, and proposal submittal requirements for procurement, remote mock-up, installation, integration, remote and installed burn-in, testing and warranty of new and existing ITS field devices, ITS populated cabinets, new wireless communication infrastructure, existing fiber network improvements, new Ethernet backbone communications equipment, digital video encoding and decoding equipment, upgrades to the existing MDOT communications hubs, upgrading certain subsystems within the MITSC Operations Center, and renovating the Blue Water Bridge Operations Room.

The intent of the Request for Proposals (RFP) is to obtain the services of an INTEGRATOR that will complete all installation and the integration of devices, subsystems and systems into an ITS communications network that meets the requirements as noted within the Systems Requirement Document contained within this project's specifications included in and attached to this RFP.

The INTEGRATOR will be selected based on a demonstration of past project experience in the successful assimilation of subsystems into a single homogenous system which allows for the central control of remote devices or subsystems while maintaining communications links that deliver video and data as directed by the central controller. This RFP includes experience and qualification requirements. Bid responses will be opened only for INTEGRATORS who demonstrate they have met the experience and qualification requirements.

A responsive proposal must cover firm and key team member qualifications, demonstrate a complete understanding of those critical path issues, demonstrate past project success and describe, in detail, the INTEGRATOR'S understanding of the project.

**Definitions of the five (5) entities that have roles described within this RFP are:**

**MDOT** – Michigan Department of Transportation - MDOT is the owner of the ITS elements that are described within this RFP, including but not limited to the MITSC

Operations Room, the BWB Operations Room, the ITS field devices and the communication infrastructure. MDOT authority in all project matters will be the MDOT Project Manager.

**SYSTEM MANAGER** – The SYSTEM MANAGER was contracted by MDOT to manage and oversee design, contracting, construction, inspection, and integration of the ITS elements described in this RFP. The SYSTEM MANAGER acts as an extension of MDOT staff and acts on behalf of and supports the MDOT Project Manager in all project-related activities, reviews, and approvals.

**CONTRACTOR** – The “brick and mortar” CONTRACTOR that will physically install, and in some cases furnish and install, ITS infrastructure such as poles, populated-by-others ITS cabinets, conduit, power drops, power cable, and power meters that are described in this RFP.

**CE CONSULTANT or Construction CE** – This is the Construction Engineering and Inspection Consultant who will inspect the work of the CONTRACTOR.

**INTEGRATOR or SYSTEM INTEGRATOR** – The INTEGRATOR is a consultant or group of consultants who will provide the specific services described in this RFP to assure the ITS elements installed by the CONTRACTOR result in fully functioning systems as described in the Concept of Operations and the requirements of this RFP. The Integrator will have to furnish, integrate, test and warrant the selected subsystems and systems that will be installed by the CONTRACTOR, such as the fully populated ITS cabinets.

**Acronyms and terms used in this RFP include:**

- ITS - Intelligent Transportation Systems. This is a generic term and when used refers in general all the specific ITS field devices, communication, data networks and operation center subsystems.
- MITSC - Michigan ITS Center. This is the MDOT traffic management center for the Detroit metropolitan area.
- BWB - Blue Water Bridge.
- RFP - Request for Proposals. The term for the document used to invite potential SYSTEM INTEGRATOR/s to submit proposals documenting their experience, qualification and approach for meeting the project requirements.
- VII - Vehicle Infrastructure Initiative. A term for wireless communication between ITS elements in the roadside and vehicles passing nearby to obtain and provide information about road conditions and incidents.
- WAN - Wide-Area Network. A wireless or wired data communication network with multiple end-user terminals, network servers, data security and other features needed to support communication within the network.
- LAN - Local-Area Network. Similar to a WAN except usually refers to a network within a specific facility such as the MITSC.

- NMS - Network Management System. Hardware and software to manage traffic on a data networks such as the VII or WAN.
- IP - Internet Protocol. IP is used to provide addresses for data communication between devices in the VII or WAN. Each element has a unique IP address.
- RF - Radio Frequency. A term used to describe systems and technology that provide wireless data communication.
- Infrastructure - Refers to the physical facilities that are used to support ITS. For example, the RF infrastructure consists of the transmitters, receivers, antennas, poles, foundations and cabling that supports wireless data communication.
- FCC - Federal Communication Commission. FCC provides oversight, governance and standards for wireless communication.
- NEPA - National Environmental Protection Act - NEPA regulations protect the human and natural environment from damage due to transportation related improvements.
- NEC - National Electric Code. The NEC develops standards for installation of indoor and outdoor electrical systems such as ITS field devices.
- DOT - Department of Transportation. This is a reference to MDOT standard specifications for construction and other policies and standards applicable to this project.
- DMS - Dynamic Message Signs. Electronic signs used to convey real-time information to travelers.
- CCTV - Closed-Circuit Television. Cameras used for traffic monitoring, incident verification and traveler information.
- VDS or MVDS - Vehicle Detection Systems. Detector used to measure traffic volume, occupancy, speeds and other parameters.
- Ethernet - A data communication protocol that describes how data from various sources and with various destinations is managed over a signal communication network such as a LAN or WAN.
- GigE - Gigabit Ethernet Communications Network. A descriptor of a high capacity data network.
- HAR - Highway Advisory Radio. HAR is usually a low-power AM or FM band radio used to provide traveler information over an area of a few miles.
- TSP - Technical Special Provisions. The TSP provide detailed technical requirements for a specific system or element.
- RWIS - Road-Weather Information System. RWIS is a system of roadside environmental and weather sensing systems, communication and software that allows MDOT users to support winter maintenance operations and traveler information systems.
- DLP - Digital Light Processing. A high-resolution, low maintenance technology used for video display units in operation centers. Alternative technologies to DLP include liquid crystal diode (LCD) or plasma which can experience loss of brightness and shadowing after a few years of continuous operation.



- QA/QC - Quality Assurance/Quality Control. A plan and process used to continuously check results and products for quality and compliance with project requirements.
- NTP - Notice to Proceed. An official notification from MDOT to the INTEGRATOR to proceed with work. Occurs after executing of the contract between MDOT and the INTEGRATOR.
- SRD - Systems Requirements Document. High-level performance and technical requirements for the ITS elements and communication networks.
- ECP - Equipment Configuration Plan. A document that identifies how each managed device will be configured in accordance with the TSP and the SRD.
- MDIT - Michigan Department Information Technology. The state agency responsible for oversight and standards for information technology in Michigan.
- ATP - Acceptance Test Plan. A plan developed by the INTEGRATOR to describe how the completed ITS elements and networks will be tested to assure compliance with the TSP and SRD.
- LDAT - Local Device Acceptance Test. A test designed to demonstrate that a local ITS element is working as intended.
- UPS - Uninterrupted Power Supply. A battery device used to maintain electrical service to critical devices during a power outage.

## II. QUALIFICATIONS

### *General Qualifications*

The **INTEGRATOR** and or Team members will be able to demonstrate successful completion of a minimum five ITS projects of similar scope and complexity. The **INTEGRATOR'S** Team task leaders, to be identified in the proposal, must also have at least 5-years experience working on a minimum of three projects of similar scope and complexity. Key/Task Leader personnel include, but are not limited to:

- Project Manager
- Lead Procurement Officer
- Technical Lead
- Lead Network Integrator
- Lead Wireless Communication Technician
- Lead Video Systems and Ops Room Technician

The wireless networks (VII and WAN) require separate qualifications documentation as follows:

### *Qualifications Criteria for the Installation of Vehicle Infrastructure Integration Systems (VII) and Wireless Subscriber and Backhaul Wide-Area Networks (WAN)*

The proposal must include documentation that the INTEGRATOR possesses the required VII and WAN wireless network expertise including successful deployment of no less than three wireless broadband data networks of \$1 million or greater size within the past five years. The qualifying INTEGRATOR must demonstrate that said networks are performing as specified for a period of greater than 1-year. The documentation must include project references and project contacts including project name, project location, project size in dollars; project description, contact name, contact title, and contact telephone number.

The Michigan Department of Transportation (MDOT) requires that the VII and WAN INTEGRATOR demonstrate within this project's qualification documentation the INTEGRATOR'S ability to successfully perform the below listed seven skill-sets and the four fundamental and primary proficiencies required for the successful deployment of a wireless network.

The following seven project skill-sets are required for the INTEGRATOR to demonstrate to be considered for this opportunity.

- Determine sources of backhaul media to hub locations in the designed network;
- Estimate the number of VII devices based on system capacity and coverage;
- Determine maximum distances from hub VII devices to non-hub VII devices that would best extend the network and ensure the highest quality of service to the end subscribers in the network;
- Ability to develop a design and the ability to perform on site survey of various wireless network planning and device placement;
- Ability to identify available mounting sites that would be ideal for the placement of wireless network devices;
- Setup of a fixed wireless backhaul system to support assigned device locations; and
- Installation of a network management system (NMS) to be used to manage all VII subscribers, hub VII devices, non-hub VII devices as well as associated WAN subscriber and backhaul devices.

These seven project skills are considered to be subsets of the four fundamental and primary proficiencies - RF network deployment, IP network deployment, civil engineering, and project management. All four of these fundamental skills would be needed to implement any data wireless network.

The INTEGRATOR must demonstrate proficiency with the following four fundamental and primary skill-sets to be considered for this opportunity.

#### RF Network Deployment Proficiency

The INTEGRATOR must demonstrate to the MDOT experience in the design and deployment of multiple broadband wireless data networks in the licensed and unlicensed bands in a wide area outdoor network configuration and cellular network expertise.

Skills that demonstrate RF proficiency:

- RF Planning and Design Services;
- Use of RF propagation tools and simulation tools for the design and optimization of a wireless broadband data network;
- Design of last mile and backhaul wireless networks;
- Full coverage assessment capabilities; and
- Ability to provide coverage guarantees in select RF coverage areas.

#### IP Network Proficiency

The INTEGRATOR must demonstrate experience in the design and deployment of multiple wireless, wired, or multi-media IP networks.

Skills that demonstrate IP Network proficiency:

- Multiple Certified IP engineers on staff;
- References to include the design, installation and optimization of multiple IP network deployments;
- Experience in providing IP network Assessments with the following areas of focus -
  - Network Performance Diagnostics;
  - Network Management Systems proficiency; and
  - Network Security audits.
- Experience in providing Network design and integration services with the following areas of focus -
  - LAN/WAN configurations;
  - Collect/define network requirements based on assessment recommendations; and
  - Develop a design for the network, network management system security.

#### Architectural and Engineering Service Proficiency

The INTEGRATOR must demonstrate experience in a complete portfolio of industry leading Architectural and Engineering and Site Development services ensuring efficient and effective turnkey solutions.

Skills that demonstrate Architecture and Engineering proficiency:

- Multiple Professional Engineers for certification of sites;
- The demonstration and listing of Site Design and Engineering projects;
- Demonstration of projects that include Site Development;
- Wireless and IP System Implementation (Infrastructure); and
- Projects including the development of Certified Site drawings for agency approval.

Compliance with any and all federal and local regulatory agency requirements is mandatory for all INTEGRATOR/s and their subcontractors. Examples of these include but are not limited to:

- FCC compliance;
- NEPA compliance;
- NEC compliance; and
- DOT compliance.

### **III. BACKGROUND AND GENERAL REQUIREMENTS**

This project involves integration of four major groups of ITS field devices -- Dynamic Message Signs (DMS/s) (existing), Surveillance Systems (CCTV) Cameras (existing), Vehicle Detection Systems (VDS/s) (existing), and wireless Ethernet communications networks. In addition, this project involves procurement, installation, integration, and testing of all required wireless and fiber communications devices and facilities necessary to link those ITS field devices to the Gigabit Ethernet (GigE) Communications Network by way of the MDOT-owned wireless and/or fiber optic communications media or other such media as depicted in the plans, built by the INTEGRATOR, or part of the existing communications infrastructure. Finally, the INTEGRATOR will procure, install, integrate and test upgrades to the MITC Operation Center and the Blue Water Bridge Operations Room.

Below is a general listing, including but not limited to, those ITS device subsystems that will be furnished and/or installed by the CONTRACTOR which is selected separately and then those devices are to be integrated into the network by the INTEGRATOR.

#### **CONTRACTOR'S RESPONSIBILITY:**

- ITS Cabinets (Install Only);
- CCTV Cameras/Surveillance Systems Remote and Tower Mounted (Furnish and Install) – Not including ITS/Video Communications Cabinet;
- Vehicle Detection Systems (VDS) (Furnish and Install);
- Dynamic Message Signs with Foundation and Structures (Furnish and Install);
- Back-of-queue Detectors and Corresponding Flasher Warning Signs (Furnish and Install);
- Back-of queue System Software Upgrade;
- Highway Advisory Radio (HAR) upgrades (Furnish and Install);
- Furnish and install Wireless Communications Network and VII infrastructure to include by not limited to poles, power drop, pole mounted box as specified and all the required infrastructure appurtenances; and
- Grounding and Lightning Suppression Systems as stipulated within the TSPs.

Table 1 - Count of ITS Device Subsystems and Cabinets (Installed and/or Furnish and Install by the CONTRACTOR and integrated into the communications network by the INTEGRATOR)

ITS Pad Mounted Cabinets	ITS Pole Mounted Cabinets	Dynamic Message Signs, Large and Small	CCTV Cameras Systems - Remote and Tower Mount	Micro-wave Vehicle Detectors	Non-invasive Magnetic Detectors	Back-Up Queue Detector & Warning Light	VII Test Bed Devices/ Poles and Power Only
16	34	13	34	32	6	3	22

Following is a listing of subsystems that will be furnished, installed, integrated and tested by the INTEGRATOR.

**INTEGRATOR'S RESPONSIBILITIES -**

- Upgrade of Backbone Communications (Hubs);
- Wireless Communication Links and Backhaul;
- VII Subsystems;
- MITSC Operation Center Upgrade;
- BWB Operation Room Upgrade, ITS Central Software and Comm-Network Hardware and Software; and
- ITS Cabinets Populated with all required ITS Devices and Communications Hardware.

Table 2 - Count of ITS Subsystems and Systems furnished, populated, installed, integrated, tested and warranted by the INTEGRATOR.

Hub Upgrades to 10GigE	Wireless Comm Links Subscriber (Each)	Wireless Comm Links Backhaul (Pairs)	VII Subsystems	MITSC Upgrade	BWB Upgrade	ITS Cabinets (13) DMS (50) CCTV/VDS
5	61	22	22	1 L/S	1 L/S	63

In addition the INTEGRATOR is responsible for procurement of central control software for the Blue Water Bridge Operation Room upgrade and upgrading of the existing RWIS software as noted within the Technical Special Provisions TSPs. The procured ITS Central Software must be furnished to the MDOT as a Region wide license with a minimum of 20-seats.

Table 3 - Individual ITS and TMC device count (ESTIMATE ONLY, INTEGRATOR RESPONSIBLE FOR FINAL COUNT) required for the INTEGRATOR to supply the necessary project subsystems and systems.

10 Gig Ethernet Backbone Switch Layer 3	5
1 Gig Ethernet Switch Layer 3 (BWB)	1
16-Port Video Multiplexer (BWB Display Operation)	1
Operator Console with (2) 21-inch Flat Monitors (BWB)	1
67-Inch DLP Video Display Unit (BWB)	1
Video Control Server/ITS Server (BWB & MITSC)	2
ITS Work Station (BWB)	1
Communications Server (MITSC)	1
Applications Server (MITSC)	1
Hardened Managed 100 mbps Ethernet Switch	62
Hardened Video Encoder MPEG-4	190
Hardened Video Decoder MPEG-4	41
Encoder/Decoder Chassis with Redundant Power Supply	17
Equipment Racks	12
Hardened Terminal Server	3
16 Multi-Port Terminal Server	4
ITS Cabinet Pole Mount	29
ITS Cabinet Pad Mount	5
Uninterruptible Power Supply	6
Subscriber Ethernet Radio (Each)	61
Backhaul Ethernet Radio (Pair)	22
VII Radio Units (Each)	22
Miscellaneous Patch Cords, Communications Cable, Connectors, all required appurtenances, etc.	LOT

#### **IV. SCOPE OF WORK**

##### **Task 1.0 Project Management**

The INTEGRATOR will be responsible for all Project Management activities of work awarded in response to this RFP. Project Management consists of organizing and managing this project, coordination, scheduling, cost control, quality control, inventory control, and performance reporting as defined below.

##### ***Task 1.1 Quality Assurance/Quality Control (QA/QC) Plan***

The INTEGRATOR is to develop and implement a QA/QC Plan that will be provided to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within fifteen (15) days of the Notice to Proceed for approval by the MDOT PROJECT MANAGER. The Plan will reflect all elements that are unique to this project including, but not be limited to procurement, installation, device testing, device configuration, inventory control, system integration, system testing, asset management and system documentation. This Plan will be utilized by the INTEGRATOR to ensure a fully functional and integrated system.

### ***Task 1.2 Meetings and Reports***

- Monthly Project Review Meetings - The INTEGRATOR will attend and participate in Monthly Project Review Meetings scheduled by the SYSTEM MANAGER and/or MDOT. These meetings will review on-going work and the project schedule, disseminate details regarding the work to be accomplished in the upcoming month and steps that will be employed to restore the project to the original project schedule if the project lags behind schedule.
- Bi-Weekly Progress Report and Two-Week Look Ahead - The Integrator will provide all requested information for the SYSTEM MANAGER's Bi-Weekly Progress and Two-Week Look Ahead Report for MDOT. The information will be delivered to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER on dates established by the MDOT PROJECT MANAGER and will be complete and accurate.
- Ad-Hoc Project Meetings - The SYSTEM MANAGER, MDOT, the CONTRACTOR, the Construction CE Consultant, or the INTEGRATOR may request periodic or ad-hoc meetings. The INTEGRATOR will attend these meetings.
- Meeting Reports - The MDOT PROJECXT MANAGER with input from the SYSTEM MANAGER will prepare draft and final reports for all project meetings. The INTEGRATOR will review the draft reports and return comments and corrections to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within two working days after receipt from the MDOT PROJECT MANAGER.
- Phone Calls and E-Mail - The INTEGRATOR will return phone calls and e-mails within one working day. E-mail may be used to document decisions between formal meetings.
- Invoices - Invoices will be submitted to MDOT on a monthly basis with a copy to the SYSTEM MANAGER along with an electronic copy of the status report.
- Attend and participate in project meetings.
- Deliverables – All INTEGRATOR deliverables will be in both paper and electronic formats. Text documents such as reports will be delivered in both MS Word and PDF format. Schedules will be delivered in both MS Project and PDF format. Plan sheets will be delivered in both Microstation and PDF format.

### ***Task 1.3 Coordination and Cooperation Between the Contractor and the Integrator***

This Integration project is an essential part of a larger ITS deployment project. Organizations that will be involved under separate contracts include:

- INTEGRATOR and CONTRACTOR Contracts Descriptions:

- INTEGRATOR - This RFP will acquire the services of the INTEGRATOR. The INTEGRATOR is responsible for the furnishing, installation and integration of all Hub communications equipment, Hub upgrade, and MITC/Blue Water Bridge Operations Room equipment required for upgrade and/or renovation as specified, the furnishing of populated (racked, stacked and integrated) ITS cabinets, the field integration into the ITS network of the furnished ITS cabinets, and finally the furnishing, installation and integration of the wireless communication network including VII and subscriber/base station broadband primary data/video network equipment.
  - The CONTRACTOR will provide and install, as noted, all field hardware and equipment including, but not limited to, remote surveillance systems (furnish and install), populated ITS cabinets (install), DMS foundation (furnish and install), DMS structures (furnish and install), DMS (furnish and install), and radio equipment pole infrastructure (furnish and install). The CONTRACTOR will also be required to provide installation services and power drops to all ITS Cabinets/Devices/DMS and field communications network devices.
  - Construction Engineering (CE) Consultant - The CE Consultant will be responsible for inspection and testing of all work performed by the CONTRACTOR.
  - The SYSTEM MANAGER will be responsible for the inspection, testing and proofing of the total ITS network and all work performed by the INTEGRATOR.
- SYSTEM MANAGER Contract Description -
    - MDOT has employed the services of a SYSTEM MANAGER who will act on behalf of MDOT. The SYSTEM MANAGER will perform post design services such as inquiry response and integration oversight, witnessing INTEGRATOR testing, system testing and proofing, and general management for the procurement of ITS devices. The SYSTEM MANAGER will oversee the installation and integration of ITS field devices to complete and ensure a functional system. The SYSTEM MANAGER will maintain a master schedule incorporating the schedules of the CONTRACTOR, the Construction CE, and the INTEGRATOR. The SYSTEM MANAGER will conduct project meetings to coordinate day-to-day activities, resolve scheduling conflicts and resolve other project issues.
    - MDOT Project Manager - MDOT will own, operate and maintain all ITS components and systems upon completion of work by CONTRACTOR, INTEGRATOR and Consultants. The MDOT Project Manager through the SYSTEM MANAGER or directly to a CONTRACTOR and INTEGRATOR may request information about



materials, schedules, testing, workmanship, costs or other items needed for MDOT to meet their project and financial management responsibilities.

It will be the responsibility of the INTEGRATOR to cooperate with all other Contractors, the Project CONTRACTOR, Consultants, the SYSTEM MANAGER and MDOT. The INTEGRATOR will work with the SYSTEM MANAGER and/or MDOT as necessary to coordinate schedules and provide opportunity to observe installation and integration activities and tests. It will be the responsibility of the INTEGRATOR to provide the MDOT and the SYSTEM MANAGER with accurate information on planned work activities and schedules. It will be the responsibility of the INTEGRATOR to avoid interfering with work efforts of the CONTRACTOR, the Construction CE and/or the SYSTEM MANAGER.

#### ***Task 1.4 Scheduling***

The INTEGRATOR is to prepare and submit project delivery schedule for approval to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within fifteen (15) days of notice to proceed. The schedule will reflect the work breakdown structure and all deliverables required to complete this project. The schedule will utilize the “critical path method” in both graphic and tabular formats using MS Project latest edition as required by MDOT. The INTEGRATOR will supply to the MDOT, 3-seat licenses for MicroSoft Project, latest edition. The INTEGRATOR will expense this software procurement to the MDOT as a direct expense to the project. The INTEGRATOR will update the schedule monthly and provide an updated copy to the MDOT PROJECT MANAGER and the SYSTEM MANAGER. The INTEGRATOR will point out changes in the schedule that may impact the final completion date and will make every reasonable effort to keep the project on schedule. If the project lags behind schedule, the INTEGRATOR will include in the updated schedule adjustments to restore the project to the original planned schedule. Review time for all submittals to the MDOT PROJECT ENGINEER and the SYSTEM MANAGER is fifteen (15) days.

#### **Task Deliverables:**

1. Project QA/QC Plan and execution certificate – 15 days after NTP.
2. Monthly Project Review and other meeting attendance
3. Input for Bi-Weekly Reports prepared by the SYSTEM MANAGER for MDOT.
4. Comments on Monthly Project Review and other meeting minutes within 2 working days of receipt of draft report from SYSTEM MANAGER.
5. Miscellaneous correspondence and project management documentation
6. Detailed project schedule (MS Project), updated monthly, including schedule adjustments – draft schedule due 15 days after receipt of notice to proceed from MDOT.

## **Task 2.0 Procurement of Communications Hardware, Computer Equipment, ITS Devices, Cabinets, Incidentals, Ops Room Equipment and Software**

### **General**

The Technical Special Provisions and Specifications attached to this RFP define the minimum requirements for equipment, ITS devices, communications equipment, computer equipment, cabinets, hardware, incidentals, video display equipment, consoles, furnishings, ITS Central Control software (a minimum of 20 license seats) and MS Project Software is to be furnished and installed by the INTEGRATOR. The INTEGRATOR will procure new equipment that meets or exceeds these specifications. Used or refurbished materials will not be permitted to be installed on the project under any circumstance without specific approval of the Engineer. If there is any equipment, hardware, software, or incidental items that are not specifically mentioned in the plans or specifications but is necessary for the INTEGRATOR to complete the installation, integration and testing, it will be the INTEGRATOR's responsibility to procure the equipment, hardware, software or incidentals without additional compensation from the Department. However, prior to incorporation of the equipment into the project the INTEGRATOR must demonstrate to the SYSTEM MANAGER that the additional pieces will not cause deterioration of system function, performance, sustainability and durability.

All equipment, hardware, materials and incidentals required by the INTEGRATOR to complete the work will remain in the possession and ownership of the INTEGRATOR until completion and approval by the MDOT PROJECT MANAGER of the SYSTEM MANAGER's final acceptance testing and acceptance program. It will be the INTEGRATOR'S responsibility to replace any devices that fail prior to acceptance by the MDOT PROJECT MANAGER and/or the SYSTEM MANAGER at no additional cost to the Department.

### ***Task 2.1 Acquisition, Review and Verification of Manufacturers' Acceptance Testing***

The equipment specifications require the equipment manufacturer to perform applicable acceptance tests on some items procured by the INTEGRATOR prior to shipment from the manufacturers or vendors facility. The INTEGRATOR will acquire Manufacturer's testing certifications from the equipment vendor for all of the items required to be complete the integration task. The INTEGRATOR will, at the option of the MDOT PROJECT MANAGER and/or SYSTEM MANAGER, submit the testing certifications to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER for review and verification. The tests and results will conform to the standards and specifications set forth in the Equipment Technical Special Provisions (TSP/s) which are attached to this RFP.

### ***Task 2.2 System Mock-up and Proofing***

As stated within the Technical Special Provisions, the INTEGRATOR is required to mock-up the proposed primary network (Hub/MITSC) within a remote site which is air conditioned and local to the project. The mock-up will consist of the full primary network as designed/specified, a representative sample of ITS device locations approved by the MDOT PROJECT MANGER with input from the SYSTEM MANAGER, computer equipment and necessary software needed for the MITSC and BWBOC upgrades. The INTEGRATOR is required to demonstrate the full function and performance of the system to the satisfaction of MDOT PROJECT MANAGER, assisted by the SYSTEM MANAGER, prior to commencing Subtask 2.3. This integration facility will also be the assembly, rack and stack, and configuration location for populating ITS cabinets. It is an option for this facility to be at a location other than the Detroit area, however, the INTEGRATOR will bear all travel expenses, lodging, meals and rental car, with no reimbursement from the MDOT, required for up to five persons, possibly including, the MDOT PROJECT MANAGER, SYSTEM MANAGER and CE Consultant to travel/stay as often/as long as determined reasonable by the MDOT PROJECT MANAGER or the SYSTEM MANAGER.

### ***Task 2.3 Primary Network Switch Over and Network Turn-up***

As stated within the Technical Special Provisions, the INTEGRAOR is required to switch over from the legacy primary network to the proposed primary network located at the MDOT Hubs and MITSC without interruption of the operations of the MITSC during any time from 5:00 am Monday morning to 10:00 pm on Friday night and including any special events as stipulated by the MDOT. The INTEGRATOR will issue to the SYSTEM MANAGER a Primary Network Switch Over and Network Turn-up Plan within 60-days of the NTP. This Primary Network Switch Over must be performed between the 15<sup>th</sup> of October 2006 and the 6<sup>th</sup> of November 2006 inclusive.

#### **Task Deliverables:**

1. Manufacturer's Acceptance Testing Documentation;
2. System Mock-up Plan within 30-days of NTP;
3. Operational System Mock-up within 45-days of NTP; and
4. Primary Network Switch-Over and Turn-Up Plan within 60-days of NTP.

### **Task 3.0 System Requirements, System Configuration and Integration, and System Acceptance**

#### ***Task 3.1 System Requirements Document (SRD)***

A System Requirements Document (SRD) will be prepared for MDOT by the SYSTEM MANAGER and issued to the INTEGRATOR fifteen (15) days after NTP. The SRD governs the specific communications systems and ITS Device subsystems contained in this project. The SRD is a structured document singularly identifying

each subsystem and specific requirement of operation, characteristic, or other attribute related to the subsystem or a component thereof. The singular requirements contained in the SRD are the basis for developing individual test cases that will be incorporated into the Acceptance Test Plan used for final acceptance of the system. The following communications systems and ITS Device subsystems are included in the SRD and will be included in the Acceptance Test Plan:

1. Primary Ethernet Communications Network (10GigEBS);
2. Dynamic Message Sign System;
3. Surveillance System CCTV Camera;
4. Vehicle Detection Systems;
5. HAR – Highway Advisory Radio;
6. RWIS – Roadway Weather Information System;
7. Wireless Data Communications system; and
8. Vehicle Infrastructure Integration (VII) System.

### ***Task 3.2 Equipment Configuration Plan***

The INTEGRATOR will produce an Equipment Configuration Plan (ECP), identifying how each managed device (such as video encoders, field switches, GigE switches, CCTV Cameras, vehicle detection systems, and dynamic message sign controllers) will be configured in accordance with the specifications attached to this RFP and with the SRD. All manageable devices will have a standard or base configuration. Site-location specific configuration values will be identified in the configuration plan. INTEGRATOR will submit the Draft ECP to the MDOT PROJECT MANGAER with a copy to the SYSTEM MANAGER for review and approval within 30 days from Notice to Proceed. The INTEGRATOR will submit the Final ECP within 15 days after receiving comments from the MDOT PROJECT MANAGER and SYSTEM MANAGER. The MDOT PROJECT MANAGER with the assistance of the SYSTEM MANAGER will oversee the development of the ECP and provide comments on the ECP to the INTEGRATOR. Integration will not be started until the ECP has been approved by the MDOT PROJECT MANGER with input from the SYSTEM MANAGER. The INTEGRATOR will utilize the IP Addressing Scheme provided by the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER in collaboration with Michigan Department Information Technology (MDIT).

### ***Task 3.3 Software Deployment Plan***

The INTEGRATOR will produce a draft plan outlining in detail how all supplied software (local, remote, central or otherwise) will be configured, integrated and made operational. The plan will also include a training outline identifying software components and training subjects for each. All changes to the plan after the system has been integrated and made operational will be provided to the MDOT PROJECT MANGAER and SYSTEM MANAGER in a final plan prior to project close-out. The INTEGRATOR is required to provide all training covered in the plan. The

INTEGRATOR will submit the draft Software Deployment Plan to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within 30 days after NTP. The INTEGRATOR will submit the final Software Deployment Plan to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER 15 days prior to commencement of the burn-in period.

#### ***Task 3.4 Acceptance Test Plan***

A minimal base Acceptance Test Plan (ATP) will be prepared for MDOT by the SYSTEM MANAGER and issued to the INTEGRATOR by the MDOT PROJECT MANAGER forty-five (45) days after NTP. The ATP includes milestones for minimal proofing of the ITS system. The minimum base ATP is traceable back to the SRD defined in Subtask 3.1. The INTEGRATOR will submit the Draft ATP to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within 45 days after receipt of the minimal base ATP from the MDOT. The INTEGRATOR will expand into more detail the Final ATP including the development of individual test cases, traceability matrices, and sequencing of the test procedures. The INTEGRATOR will submit the Final ATP within 15 days after receiving comments from the MDOT PROJECT MANAGER and the SYSTEM MANAGER. All acceptance tests will be conducted by the INTEGRATOR and witnessed/verified by the SYSTEM MANAGER. The INTEGRATOR will provide a ATP schedule Milestones within the Final ATP will include, but are not limited to, the following:

1. Device Asset Management – The INTEGRATOR will log all devices, including those supplied by others (ie. CONTRACTOR) into an inventory tracking and asset management database. The INTEGRATOR will submit the proposed inventory tracking and asset management database for approval by the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER. The INTEGRATOR will maintain the device inventory daily. The INTEGRATOR will deliver the updated inventory to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER, along with packing slips, monthly. The INTEGRATOR is required as part of this task to hold a training class on the system for a maximum of 10 participants to be held within 45-days after NTP. The INTEGRATOR will provide all checklists, inventory, software and other documentation to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER on a bi-weekly electronic transfer/update. At the close of the project, the INTEGRATOR is required to turn over all data and software licenses to MDOT.

The INTEGRATOR will be liable for security and insurability of all equipment received. The MDOT PROJECT MANAGER and/or the SYSTEM MANAGER will have access to equipment as deemed necessary by MDOT and/or the SYSTEM MANAGER.

2. Component Level Test – The INTEGRATOR will conduct component level testing on individual electronic devices including, but not limited to, the individual operational functions of DMS sign controller, CCTV, MVDS, Network Switches, Encoders, Terminal Servers, UPS, etc. The INTEGRATOR will generate a component level testing matrix for each device listing, device function and desired result. The testing matrix will be fully traceable back to the SRD developed earlier. The SRD will always govern testing requirements for pass/fail criteria. The INTEGRATOR will notify to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER when component level testing is planned so that the MDOT PROJECT MANAGER and/or the SYSTEM MANAGER can observe and verify component testing. Upon successful completion of the Component Level Test, the INTEGRATOR may begin configuring the device. All component testing documentation will be provided to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER on a bi-weekly electronic transfer/update.
3. Local Device Assembly Test (LDAT) – The LDAT consists of the testing of specific functional or performance requirements of a local device assembly as defined in the plans and specifications for the project. Tests are performed after ITS Device Assembly installation by the CONTRACTOR and/or INTEGRATOR and after completion of the field integration by the INTEGRATOR. MDOT with input from the SYSTEM MANAGER will provide an LDAT testing matrix for each device assembly location, device function and desired result. The testing matrix will be fully traceable back to the SRD developed earlier. The SRD will always govern testing requirements for pass/fail criteria. The INTEGRATOR will conduct all tests required by the SRD and LDAT. The INTEGRATOR will notify the MDOT PROJECT MANAGER and the SYSTEM MANAGER at least five days in advance of conducting LDAT testing activities so that the MDOT PROJECT MANAGER and/or the SYSTEM MANAGER can observe and verify all LDAT activities and results. The INTEGRATOR will provide all LDAT documentation to to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER upon completion.
4. Final System Test – The culmination of all of the above tests. From the central system, utilizing the system software supplied by field device manufacturers and the Central System Software supplied by the INTEGRATOR according to the TSP's, tests will be executed to specific ITS devices to verify function and performance meets the requirements defined in the Systems Requirements. The final system test may not commence until all LDAT's have been conducted, passed and verified by the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER. The MDOT PROJECT MANGER with input from the SYSTEM MANAGER will notify the INTEGRATOR when Final System Testing may commence. The MDOT PROJECT MANAGER with input from the SYSTEM MANAGER will generate the final system testing matrix. The testing matrix will be fully traceable back to the SRD developed earlier. The SRD will always govern

testing requirements for pass/fail criteria. The Final System Test will be conducted by the INTEGRATOR. The INTEGRATOR will notify to the MDOT PROJECT MANAGER and the SYSTEM MANAGER at least five days prior to commencing with Final System Test activities so that the MDOT PROJECT MANAGER and/or SYSTEM MANAGER can observe and verify all tests and test results. The INTEGRATOR will provide all Final System Test documentation to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER upon completion.

5. Burn-in Period – The INTEGRATOR is required to request in writing from the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER commencement of the burn-in period. ALL project documentation must be submitted to and approved by the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER prior to submitting this burn-in request. Upon written authorization from the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER the INTEGRATOR will begin the 30-day Burn-in Period. The burn-in will continue on consecutive days unless an equipment failure occurs. In the event that an equipment failure occurs, the Burn-in Period will be stopped, and the INTEGRATOR will, within two hours after notification of any problem as identified by the MDOT PROJECT MANAGER, SYSTEM MANAGER or INTEGRATOR himself, perform a diagnostic test. The INTEGRATOR will complete all necessary work to correct the problem within 24 hours of notification, unless the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER allows additional time. The INTEGRATOR will provide a written failure report to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER within 72 hours after notification of the problem. The written failure report will fully describe the problem, its cause and all actions taken. All equipment, materials, or software listed in the report will contain the manufacturer's name, model and serial number. All equipment or modules used in the replacement or repair will meet the SRD and TSPs and be subject to the above testing requirements. The INTEGRATOR will not perform field repairs on electrical or electronic equipment, instead malfunctioning electrical or electronic equipment will be replaced in kind or as approved by the MDOT PROJECT MANAGER with input from SYSTEM MANAGER. The INTEGRATOR is required to coordinate manufacturer return merchandise authorizations (RMAs) with the MDOT assigned purchasing manager. Within two working days after receiving the equipment failure report, the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER will notify the INTEGRATOR in writing whether the Burn-in Period will be commenced, extended (i.e., Burn-in Period time extended until a set time is reached), or restarted (i.e., set Burn-in Period time back to Day Zero). In any event, the Burn-in Period time will be commenced, extended or restarted upon the written notification by the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER. The INTEGRATOR will provide all Burn-In Period documentation to the

MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER upon completion.

The acceptance tests listed above will be developed for the MDOT PROJECT MANAGER by the SYSTEM MANAGER, executed by the INTEGRATOR, and verified by the MDOT PROJECT MANAGER with input from the SYSTEM MANAGER to ensure a fully functional and integrated system. The conditional acceptance period will be 45-days after successful completion of the burn-in period. Upon completion of the conditional acceptance period, the system will be accepted by the MDOT PROJECT MANAGER with input from SYSTEM MANAGER.

**Task Deliverables:**

1. Systems Requirement Document (SRD) .....
2. Draft Equipment Configuration Plan (ECP) (30 days after receipt of SRD from MDOT);
3. Final Equipment Configuration Plan (ECP) (15 days after receipt of comments on Draft ECP from MDOT);
4. Draft Software Deployment Plan (30 days after NTP)
5. Final Software Deployment Plan (15 days prior to commencement of burn-in)
6. Software Training as identified in the Software Deployment Plan
7. Draft Acceptance Test Plan (45 days after receipt of the minimal base ATP from MDOT).
8. Final Acceptance Test Plan (15 days after receipt of comments from MDOT).
9. Ongoing Asset Management for the duration of the project
10. Training on Asset Management System
11. Asset Management System software and database
12. Completed Inventory Database (Updated Daily, Transmitted to MDOT bi-weekly);
13. Component Level Test Matrix;
14. Component Level Tests;
15. Local Device Assembly Test Matrix;
16. Local Device Assembly Tests;
17. Final System Traceability Matrix;
18. Final System Tests;
19. ALL project documentation;
20. System Burn-in; and
21. All ITS Devices configured, tested, inventoried, labeled, and ready for installation and field integration

**Task 4.0 Field Integration**

Once the CONTRACTOR has installed and supplied the power and communications interconnect to each ITS device as stated in the plans and specifications and approved by the MDOT PROJECT MANAGER with input from CONSTRUCTION CE CONSULTANT and/or the SYSTEM MANAGER, the INTEGRATOR will integrate each device into the fiber and/or wireless communications network in accordance



with the Plans and Specifications. Coordination with the MDOT PROJECT MANAGER, the SYSTEM MANAGER AND CONTRACTOR are required for the scheduling of the installation and integration of all the ITS devices. Once physical installation of the infrastructure by the CONTRACTOR is completed and approved by the MDOT PROJECT MANAGER with input from CONSTRUCTION CE CONSULTANT and the SYSTEM MANAGER, the INTEGRATOR will field integrate the ITS device/cabinet into the ITS network and power-up the ITS device/cabinet within 72-hours. The MDOT, with input from the SYSTEM MANAGER, will verify the ITS devices are placed in the correct locations and that all ITS devices are functioning properly. Upon completion and sign-off of the MDOT PROJECT MANAGER, with input from the SYSTEM MANAGER, the INTEGRATOR will perform the Local Device Assembly Test, and then the Final System Test, followed by the Burn-In Period as described and required within this Scope of Services. The INTEGRATOR must verify communications between ITS field devices and subsystems between each ITS device location and that device/subsystem designated communication hub.

The upgrade task of all active ITS devices, subsystems and communications components and equipment contained in the Communications Hubs will include, but is not limited to - Gigabit Ethernet switches, other switches and device servers, and all cables or connectors necessary for the successful operation of the communications system.

Prior to starting integration activities, the INTEGRATOR will submit a field device and communications hub integration checklist for approval to the MDOT PROJECT MANAGER with a copy to the SYSTEM MANAGER.. This checklist will identify that all integration tasks have been completed and are documented. In concert with, and as part of, the delivery of the integration checklist, the INTEGRATOR must deliver the as-built communications network hub network schematic and circuit diagram.

#### ***Task 4.1 As-Built Plans and Network Schematics***

The INTEGRATOR will deliver to the System Manager three sets of complete As-Built plans and Schematics within 30-days of completion of the Final Acceptance Test. These as-built plans will be delivered as follows - three sets of all circuit drawings including conductor and patch cord identification notations and locations, three sets of individual hub network topography and hub layouts, passive network testing documentation, communications equipment locations and the required asset management information including device serial numbers, etc.

#### **Task Deliverables:**

1. Coordination with the MDOT PROJECT MANAGER, SYSTEM MANAGER, CONSTRUCTION CONTRACTOR, CONSTRUCTION CE CONSULTANT;

2. Installation and Integration Schedule;
3. All configured ITS devices installed and integrated into the passive communications network Delivery of bench tested ITS devices to the CONTRACTOR for installation and to the field locations where the INTEGRATOR is to integrate the ITS devices;
4. Communications System Integration at all Communications Hubs; and
5. Completed Integration Checklists for all ITS device locations and all Communications Hubs. Delivery of four (4) integration documentation packages which include ITS device acceptance tests and Manufacturers' Operations & Maintenance Manuals to the following recipients upon completion of this Task Work Order:
  - a. MDOT ITS Maintenance – two (2) copies;
  - b. CONTRACTOR – one (1) copy, included with each device cabinet (this copy is to remain in the cabinet); and
  - c. SYSTEM MANAGER - two (2) copies.
6. Three sets of As-Built Plans, Circuit Drawings, Schematics and Hub Layouts; and all required asset management information.

## **V. MISCELLANEOUS**

### ***Length of Service***

Services to be rendered by the INTEGRATOR, as herein described, will commence upon written notice to proceed from the MDOT, and are to be completed within twenty-three (23) months from the date of such notice. All equipment purchased under this contract, i.e. cables, testing equipment, devices, etc. become the property of the MDOT and will be turned over to MDOT at the end of the project.

### ***Warranties and Maintenance***

Warranty for all individual ITS and Communications devices provided by the INTEGRATOR is to be five years (unless noted differently within that device's Special Provision) with the full warranty period beginning at final acceptance. The INTEGRATOR will be responsible for maintenance of all subsystems and systems during the integration period and for the first year of the warranty period. Upon the end of the first year of warranty, the INTEGRATOR will be transfer the warranty to the MDOT.

Over and above device vendor or manufacturer's warranty, the INTEGRATOR is required to warrant his work to be "free of defect" for a period of one-year after final acceptance covering all integrated subsystems and systems. The INTEGRATOR is required to use installation and integration techniques that are consistent with equipment manufacturer recommendations and standards to avoid nullifying any warranty for equipment pre-existing this project and/or installed by others.

### ***Product Manuals, Maintenance Manuals and Operations Manuals***

At final acceptance the INTEGRATOR is required to deliver to MDOT PROJECT MANAGER with a single copy to the SYSTEM MANAGER five copies of all product manuals, maintenance manuals and operations manuals bound and tab divided for ease of reference.

### ***Training***

Training requirements for this project are as specified within the Special Provisions and as detailed in Subtask 3.4.

## **VI. PROPOSAL SUBMITTAL REQUIREMENTS**

The following are key **minimum** requirements for all interested parties which should be submitted with their proposal. To be considered for this project, the potential INTEGRATOR must demonstrate that they meet and/or exceed the following minimum submittal requirements:

- INTEGRATOR understanding of the scope and nature of the project;
- INTEGRATOR'S approach for completing all aspects of the project;
- INTEGRATOR'S experience with similar projects, including example projects, and references who can be contacted to verify INTEGRATOR'S performance;
- Identification of Team members and Task Leaders with description of their experience, example projects and references;
- Listing of key personnel, experience, training, certifications, example projects, and references. Statement of availability of and commitment to use these individuals;
- Proposed equipment and device cut-sheets and specifications; and
- Quality Control and Assurance Plan.

## **BID SHEET**

Scope of work for the Integrator is the procurement, remote mock-up, installation, subsystem integration, field integration, remote and installed burn-in, testing and warranty of new and existing ITS subsystems and systems, including but not limited to the population of ITS cabinets both pole mounted and pad/ground mounted, new wireless communication infrastructure, existing fiber network improvements and upgrades, renovation and upgrades at the MDOT communications Hubs and Operations Centers, new Ethernet backbone communications equipment, installation and integration of a VII Test Bed, digital video encoding and decoding equipment, upgrading certain subsystems, including but not limited to central system software integration, within the MITSC Operations Center, and the complete renovation, including but not limited to central system software integration, of the Blue Water Bridge Operations Room.

## PAY ITEMS

**All entries on this page must be handwritten in ink or computer generated.**

**See RFP Special Provisions for full explanation of each bid item.**

Bid amount should be calculated as follows:

Quantity x Unit Price = Bid Amount

Quantity of Lump Sum = 1

ITEMS OF WORK	QUANTITY	UNIT PRICE	BID AMOUNT
Backbone Communications Network	Lump Sum		
BWBOC Modifications	Lump Sum		
Wireless Link, Cellular	2 Each		
Wireless Link, Backhaul	10 Each		
Wireless Link, PTMP, SU	71 Each		
Wireless Link, PTMP, BSU	44 Each		
Cabinet, ITS, Pole Mounted	33 Each		
Cabinet, ITS, Ground Mounted	18 Each		
VII Test Bed Access Point	12 Each		
VII Test Bed Wireless Router	21 Each		
VII Test Bed Device Enclosure, Fiberglass with Sunshield	0 Each*	N/A	No Bid Amount
Lighted Arrow, Type C, Furn	2 Each		
Lighted Arrow, Type C, Oper	2 Each		
Lighted Arrow, Type C, Standby	1 Each		
Minor Traf Devices	Lump Sum		
Plastic Drum, High Intensity, Lighted, Furn	150 Each		
Plastic Drum, High Intensity, Lighted, Oper	150 Each		
Sign Cover	10 Each		
Sign, Type B, Temp, Prismatic, Furn	980 SFT		
Sign, Type B, Temp, Prismatic, Oper	980 SFT		
Truck Mtd Attenuator, Furn	2 Each		
Truck Mtd Attenuator, Oper	2 Each		

\*Note: VII Test Bed Device Enclosure, Fiberglass with Sunshield will be procured by the CONTRACTOR

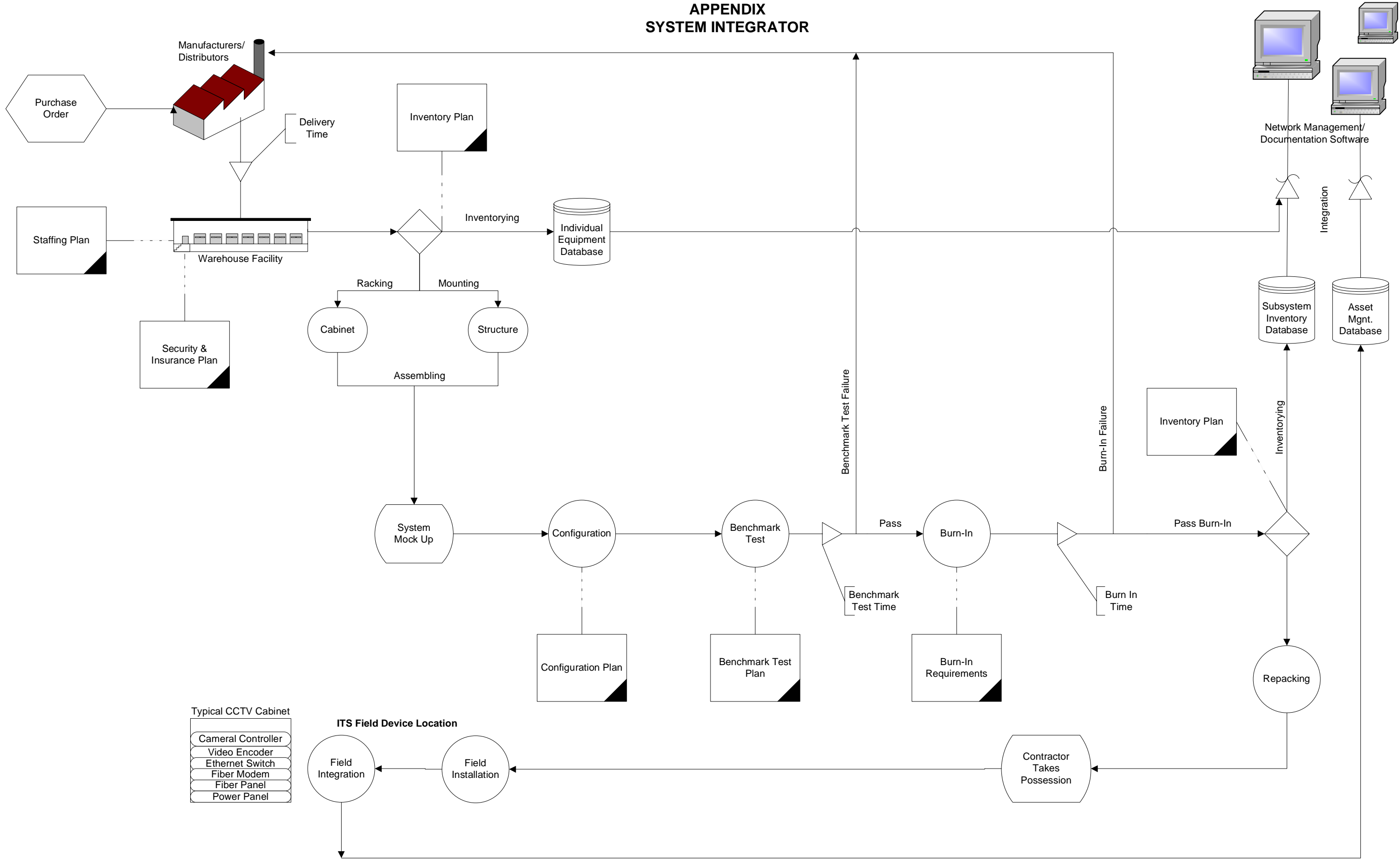
Total Bid: \_\_\_\_\_

Consultant Name:	
Consultant Address:	
Date:	

The Michigan Department of Transportation reserves the right to reject any or all bids.

Check "UNIT PRICE" column for omissions before entering bid total.

APPENDIX  
SYSTEM INTEGRATOR



INTEGRATOR PROCESS FLOW CHART  
MICHIGAN DEPARTMENT OF TRANSPORTATION

**UTILITY NOTICE TO BIDDER  
AND  
UTILITY COORDINATION REQUIREMENTS**

DES: MM

1 of 3

11-02-05

**GENERAL**

The Contractors attention is directed to the requirements for cooperation as covered in Article 104.07 of the 2003 Standard Specifications for Construction.

Utility companies may require utility relocations and adjustments within the limits and during the life of this project. The contractor shall cooperate and coordinate construction activities with these agencies as stated in the MDOT Standard Specifications for Construction. Utility information and possible relocation coordination work is listed below. Contact persons and instructions are included in the list.

**WAYNE COUNTY**

**Michcon:**

Michcon has 8 inch, 12 inch, and 16 inch pipelines along Harper Road, in the vicinity of Allard Ave. and Vernier Rd.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact Person for Michcon:**  
**Distribution and Drafting Clerk**

**Phone: 313 577-7327**

**ST. CLAIR COUNTY**

**Semco Energy Gas Company**

Semco Gas has a 2 inch pipe line crossing I-94 in the vicinity of Gratiot Ave, and crossing I-69 in the vicinity of Wadham's Rd

**Contact Person for Semco Energy**  
**Brad Dietzel**

**Phone: 810 887-3068**



**OAKLAND COUNTY****DTE Energy (Michcon):**

DTE Energy (Michcon) has a 36 inch pipeline (Milford Loop "L") crossing under I-96 in the vicinity of Old Plank Road.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact Person for DTE Energy (Michcon):****Erick Dole****Phone: 248 486-6506****City of Novi:**

The City of Novi has 2 water main crossings and 3 sanitary sewer crossings under I-96 along with a lift station within the City of Novi limits.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact Person for City of Novi:****Brian Coburn****Phone: 248 347-0454****Consumers Energy -Transmission & Storage:**

Consumers Energy (Transmission & Storage) has a 16 inch CECO gas transmission pipeline crossing (Line 2800) under I-96 between Kent Lake Rd. and Milford Rd., a 16 inch CECO gas transmission pipeline crossing (Line 1600) under I-96 between Novi Rd. and Taft Rd., and a 24 inch pipeline crossing under I-96 between South Hill Rd. and Old Plank Rd.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact Person(s) for Consumers Energy (Transmission & Storage):****TJ Coppernoll****Phone: 517 788-0998****Richard Cottrell****Phone: 517 788-0817****Consumers Energy - Distribution:**

Consumers Energy (Distribution) has a 4 inch gas main crossing under I-96 at Milford Rd., a 2 inch gas main running along the ramp in the north east quadrant of the I-96/Milford Rd. interchange and an 8 inch gas main crossing under I-96 at Wixom Rd.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact person(s) for Consumers Energy – Distribution:**

<b>Mike Jablonski</b>	<b>Phone: 248 858-4405</b>
<b>Debra Boyle</b>	<b>Phone: 248 858-4439</b>
<b>Kurt Adams</b>	<b>Phone: 517 545-8711</b>
<b>Dominic King</b>	<b>Phone: 734 513-6268</b>

All work required and cost incurred for probing and/or exposing and/or hand digging in the vicinity of any utility involved with this project will not be paid for separately but shall be included in the cost of other pay items in the contract.

**MACOMB COUNTY****Michcon:**

Michcon has a 8 inch, 12 inch, and 16 inch pipelines along Harper Road, in the vicinity of Allard Ave. and Vernier Rd.

The contractor is to use extreme caution when working in the vicinity of these facilities. The contractor may have to hand dig within the vicinity of these facilities.

**Contact Person for Michcon:**  
**Distribution and Drafting Clerk**

**Phone: 313 577-7327**

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**PROTECT ITS INFRASTRUCTURE**

DES:MM

1 of 3

08-04-04

- a. Description.** Protection of the existing and newly installed MDOT MITS infrastructure during construction activities is critically important for the safety of construction workers and the general public. The MITS intelligent transportation system (ITS) infrastructure is not protected by the contractor calling MISS DIG. A separate request, using the MDOT Form 5300 must be faxed to the ITS Engineer at the MITS Center at (313) 256-9036 at least three (3) business days in advance of any digging. In case of emergencies, please call (313) 965-0777; the Control Room Operator will get assistance. The Control Room is staffed 24 hours a day. Any damage to this critical infrastructure shall be repaired immediately by the contractor causing the damage, or by another contractor, at the sole discretion of the MITS ITS Engineer. All costs of the emergency repairs shall be paid by the contractor responsible for the damage regardless of who does the repair.

The Staking Request form, attached as Page 3 of 3, is available through the Internet at: <http://mdotwas1.mdot.state.mi.us/public/webforms/public/5300.pdf> and at the MDOT Project Office.

**1. Critical Infrastructure -- Hand Digging**

The contractor shall hand dig to confirm the location of MITS infrastructure whenever the proposed work is within ten feet of the marked location, or when directed by the Engineer. The cost of hand digging shall be included in the applicable construction pay items.

**2. Critical Infrastructure -- Protection**

Wherever indicated on the plans or by the Engineer the contractor shall provide rectangular steel cover plates of at least 8 by 8 feet in size and 1 inch thick to serve as a buffer and shield between traffic loads or demolition and the critical infrastructure. These plates shall be used to cover handholes that will be over driven by traffic during construction; to protect conduit runs from bridge demolition activities and debris; and wherever indicated by the Engineer. These plates may be necessary over magnetometer conduits until the pavement is placed over them. The cost of plating shall be included in the applicable construction pay items.

**3. Critical Infrastructure -- Renewing Markings**

Whenever construction activities obliterate facility staking markings, the burden is on the Contractor to place a subsequent request to MITS for freshening the system markings or flags. It is the Contractor's responsibility to assure they know where all MITS facilities are after the initial staking at each site.

**b. Measurement and Payment.**

The costs associated with this pay item will not be paid for separately, but are to be included in the applicable pay items that might cause harm to the MITS infrastructure, such as, but not limited to: guardrail installation, fence installation, pavement placement.

[Clear Form](#)

Michigan Department  
of Transportation  
5300 (04/04)

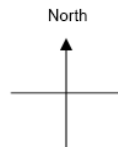
## MIT S UNDERGROUND INFRASTRUCTURE LOCATING/STAKING REQUEST

FAX Staking Requests to: MDOT/MTS at 313-256-9036

NAME		TITLE	
COMPANY/ORGANIZATION		CURRENT DATE	TIME
PHONE	FAX	OTHER (mobile, pager..)	

GENERAL LOCATION FOR STAKING REQUEST (County, city & major cross streets)

DETAILED LOCATION DESCRIPTION & SKETCH (Attach construction drawings, if available)

SKETCH AREA (Below)

DESCRIPTION OF WORK TO BE PERFORMED


LIST OF SUBCONTRACTORS ON THIS JOB	DATE WHEN EXCAVATION/UNDERGROUND WORK IS SCHEDULED TO BEGIN
------------------------------------	--

NAME OF MDOT ENGINEER ON THIS JOB	PHONE NUMBER
-----------------------------------	--------------

ADDITIONAL INFORMATION


**NOTE:** Staking requests must be received in writing five (5) days prior to digging.

FOR MDOT/MTS USE ONLY:

Work Order Number: \_\_\_\_\_

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**BASIC MATERIALS AND METHODS FOR ITS WORK**

DES: MM

1 of 16

03-14-06

**a. Description.** This special provision describes the basic materials and methods for Intelligent Transportation Systems (ITS), required for this project. This work is to be done in accordance with the 2003 Standard Specifications for Construction except as modified herein, the contract documents, manufacturer's instructions, and shop drawings.

1. General.

A. This special provision applies all work to be completed in this project including but not limited to:

(1) ITS Cabinets,

This work consists of furnishing, populating with equipment (including burn-in and testing, field integration and warranty of 336S Special Pole Mounted, and 332 Special Ground Mounted, ITS Cabinets. The ITS Cabinet provides an environmentally secure enclosure to house ITS field device equipment, subsystems, ITS network communications equipment and surge protection. The cabinet will be designed for the explicit use of and populated with housing and protecting sensitive electronic equipment (Encoders, Ethernet switches 10/100 Mbps, media converters, port/terminal servers, wireless communications equipment, and other related components, etc.)

(2) Backbone Communications Network

This work is to consist of furnishing, mocking-up, installing, integrating and testing the primary communications network supporting the delivery of video image and data from and to the ITS field devices to and from the Michigan Intelligent Transportation Management Center (MITSC); this primary communications network is herein referred to as the Backbone Communications Network (BCN) equipment as depicted on the Plans. No additional items or payment other than what is indicated herein is required in this estimate of work. This work is to be done in accordance with the Michigan Department of Transportation 2003 Standard Specifications for Construction, except as modified. Items covered under this Special Provision include the following:

(a) Multi-port Terminal Servers (MTS) 16-port

The MTS aggregates up to 16 serial data connections and provides communications to each serial port by way of Ethernet/IP;

(b) 10-Gig Ethernet Backbone Switch (10GigEBS)

The 10GigEBS is a modular backbone switch providing 10Gbps, 1Gbps, 100Mbps, and 10Mbps Ethernet/IP connectivity via optical fiber or twisted pair copper conductor;

(c) Video Control Server (VCS)

The VCS contains the necessary hardware and software to provide IP video

switching capability to client workstations in an Ethernet/IP network environment;

(d) Communications Server (CS)

The CS contains the necessary hardware and software to provide Ethernet/IP and serial connectivity between other system servers, client workstations, remote users and field devices in an Ethernet/IP network environment;

(e) Applications Server (AS)

The AS contains the ATMS/ITS applications necessary to provide a user interface and the functionality required to support operating the system.

(f) Digital Video Encoder/Digital Video Decoder (DVE/DVD), Hardened

The DVE encodes an analog video signal and a serial data signal (for PTZ) into an Ethernet/IP format. The DVD decodes the digital video stream from Ethernet/IP into an analog video signal and a serial data signal (PTZ); and

(g) Uninterruptible Power Supplies (UPS)

The UPS provides uninterrupted power to critical equipment and systems.

(3) Blue Water Bridge Operations Centers Upgrade

This work consists of modifying the existing Blue Water Bridge Operations Center (BWBOC). The BWBOC is located at 1410 Elmwood, Port Huron, MI 48060. This work must be done in accordance with the Michigan Department of Transportation 2003 Standard Specifications for Construction, except as modified. Items and work included in the BWBOC upgrade are:

(a) 1Gig Ethernet Backbone Switch (1GigEBS)

(b) ITS System Server

(c) Digital Video Encoder MPEG4 (DVE)

(d) Digital Video Decoder MPEG4 (DVD)

(e) Digital Video Encoder/Decoder Rack Chassis

(f) Digital Video Encoder/Decoder Rack Chassis Redundant Power Supply

(g) Uninterruptible Power Supply (UPS)

(h) Communications and Server Racks

(i) Demolition BWB OPS RM

(j) Re-construction BWB

(k) Miscellaneous Communications Wiring

(l) Power Service Upgrade If Required

(m) Jumpers and Patch Cords

(n) Remote System Mock-up and Demonstration

(o) Full System Burn-In

(p) System Integration of Ops-RM Equipment and Server Aggregation

(q) 67-Inch DLP Video Display

(r) Operator Console with (2) Flat Screen Monitors, (1) Operator's Chair

(s) 16-Input Color Video Multiplexer

(t) ITS Work Station

(4) ITS wireless communications network infrastructure for field devices

(a) Broad-band wireless backhaul network

This work consists of the installing and testing a Wireless Backhaul Link at locations designated on the Plans. In the plans, one half of a complete link is called out as "Wireless Link, Backhaul." This work is to be done in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

(b) Point-to-Multi-Point (PTMP) wireless network

This work consists of the furnishing, installing, integrating and testing of a Point-to-Multipoint Wireless Network Segment (PTMP) at locations designated on the Plans. A PTMP link is comprised of a Base Station Unit (BSU) and a Subscriber Unit (SU) and all cabling, antennas and the system appurtenances required to complete a functional link. A single BSU is capable of communicating with multiple SU's in a point-to-multipoint configuration as indicated on the Plans. This work must be performed in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

(c) Cellular wireless links

This work consists of the furnishing, installation, integrating and testing of the device-level, environmentally hardened, cellular wireless modem and service. The wireless modem must be outdoor/industrial-grade wireless modem that provides wire-speed Ethernet (10 mbps) connectivity from the remote ITS devices where this wireless modem is to be installed to the ITS network connection point at the BWBOC. The furnished Wireless Link, Cellular must be fully compatible and interoperable with the ITS network trunk Ethernet network interface.

(5) Vehicle-Infrastructure Initiative (VII) devices and network

This work consists of the furnishing, installing, integrating and testing of a Vehicle Infrastructure Integration (VII) Test Bed Network at locations designated on the Plans. A VII Test Bed Network is comprised of all Wireless Routers (WR), Access Points (AP), enclosures, all cabling, and the system appurtenances required to complete a functional network. An AP will be located at points along I-96 that will allow access to the backhaul network as indicated on the Plans. A WR will be the interface between the vehicle access wireless client card and the test bed network.

- B. The Integrator is to furnish, install, test and integrate all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

2. Permits and Licenses:

- A. The Integrator is to be responsible for acquiring the permits and necessary insurance riders for all required utility and inspection permits, including all costs associated with these permits and insurance riders.
- B. The Integrator is to be responsible for all overtime inspection costs by utility companies and other agencies required for work performed at the discretion of the Integrator outside the utility company's normal working hours.
- C. The Integrator is responsible for payment of all utility bills and charges prior to equipment acceptance by MDOT. All utility accounts will be transferred as designated by the Engineer within two weeks of equipment acceptance by the Engineer.
- D. Construction Phase Submittals.



## (1) General

- (a) Except for the project Close Out Documentation, all shop drawings, schematics, material lists, and details are to be submitted to the Engineer within ninety (90) days of Integrator's Notice to Proceed.
- (b) No extension of time will be allowed due to Integrator's failure to complete and obtain acceptance of any submittal nor will delays to the project for completing this work be allowed as the basis of any claim. Seven (7) copies of each submittal are to be transmitted to the Engineer, unless otherwise specified.
- (c) Submittals not transmitted as specified will be returned without review, and must be resubmitted.
- (d) Review and acceptance of submittals by the Engineer does not relieve the Integrator of the responsibility for errors or conformance with the contract documents.
- (e) All submittals are to be accompanied by a Letter of Transmittal that includes the following information:
  - (i) Date of submittal
  - (ii) Name of company making submittal
  - (iii) Name of the Integrator sending submittal
  - (iv) State Job Number and Control Section
  - (v) Federal aid project number
  - (vi) Itemized list of enclosures (e.g., five copies of Inside Wiring Submittals)
  - (vii) Recipient name and department (i.e. to the attention of ...)
  - (viii) Action requested (e.g., please review submittals for approval)

## (2) Required Submittals:

- (a) Site Evaluation Report: The Integrator is to submit Site Evaluation Reports for all sites requiring assessment of construction site prior to equipment installations as detailed in the Plans.
- (b) Shop Drawings and Equipment Data:
  - (i) The Integrator is to submit Shop Drawings and Equipment Data for all prefabricated ITS equipment and components if required by the contract documents.
  - (ii) Samples are to be submitted if required by the contract documents, or if requested by the Engineer.
    - 1. Shop Drawings.
      - a. Allow ten (10) working days for the Engineer to review detailed plans prior to authorization to commence installation.
      - b. The Integrator is to verify, in writing, final hardware and software installation configuration plans with the Engineer prior to any field installation.
    - 2. Equipment Data.
      - a. Prior to ordering material, the Integrator is to submit equipment data information. Equipment data sheets are to clearly state equipment compliance with equipment specifications
      - b. The Integrator is to submit five (5) indexed and bound sets of equipment data including but not limited to the following items identified in individual specification and special provision sections.

Cabinet, ITS, Pad Mounted
Cabinet, ITS, Pole Mounted
Power Co. (Est. Cost to Integrator)
Meter and Service Disconnect, ITS
VII Test Bed Access Point
VII Test Bed Wireless Router
Wireless Access, Cellular
Wireless Link, Backhaul
Wireless Link, PTMP, BSU
Wireless Link, PTMP, SU
BWBOC Modifications
Backbone Communication Network

- c. The index is to list equipment being submitted and the specification section references.
- d. Equipment data is to include, but is not limited to, the following:
  - A complete equipment list including manufacturers' names, model numbers, and quantities of each item; manufacturers' data sheets on all equipment items, including parts list and part numbers; performance characteristics and capacities; dimensions and clearances; wiring diagrams and controls; and other pertinent information.
  - Equipment racks and console layouts showing locations of all equipment items.
  - Construction details for any custom fabricated items, including interfaces, panels, removable control panels, and wall plates. These details are to show dimensions, materials, finishes, and color selection.
  - ITS schematics showing detailed connections to all equipment with wire/cable number, terminal block number, and color-coding. Distinct wire numbers is to be translated to label permanently affixed to each cable. Device connection and protocol information, and labeling schema is to also be provided.
  - Integrator or its Subcontractor's certificate by the manufacturer to install the equipment

(c) Work Plan:

- (i) A Work Plan is to be submitted to the Engineer for review at the preconstruction meeting.
- (ii) The Work Plan will be discussed at the preconstruction meeting. Within two (2) weeks of receipt, the Engineer will either accept the plan as submitted or request revisions. First two weeks schedule will be reviewed at the preconstruction meeting and the Engineer will approve or request change to the first two weeks schedule as a part of the meeting.

- (iii) Work on this project is not to begin until the Work Plan has been accepted by the Engineer.
  - (iv) The Work Plan is to include primary work tasks and schedule for each indicating start and completion dates with clear identification of long lead-time items and critical path tasks.
- (d) Material Handling and Storage Plan:
- (i) Thirty (30) days prior to any equipment arriving at the site, the Integrator is to submit ten (10) copies of a Material Handling and Storage Plan to the Engineer.
  - (ii) The Material Handling and Storage Plan is to give details of the equipment and facilities to be provided and the procedures to be adopted by the Integrator for the safe and efficient handling and storage of all equipment and material.
  - (iii) The Engineer is to review the plan and respond within ten (10) working days of receipt indicating either acceptance or rejection with required changes of the plan.
  - (iv) The Integrator is to address all comments and resubmit the plan within seven (7) working days after receiving the rejection notice and comments.
  - (v) The Integrator is not to ship materials to the site until the Materials Handling and Storage Plan is accepted by the Engineer.
  - (vi) The Department will not make provisions for temporary storage of equipment prior to deployment in specified locations. All costs incurred in storage, setup, handling, and transportation is to be included in bid.
  - (vii) The Department assumes no responsibility for stored equipment. The ownership and title to equipment is not to be vested in the Department before the equipment has been delivered, tested, and accepted.
  - (viii) All equipment is to be fully insured and maintained by the Integrator until final acceptance by the Engineer.
- (e) Equipment Installation Plan:
- (i) Thirty (30) days prior to the first installation of equipment, the Integrator is to submit ten (10) copies of the Equipment Installation Plan to the Engineer. Should the Equipment Installation Plan may be integrated into the Work Plan, the submittal time frame of the Work Plan applies.
  - (ii) The Engineer is to review the plan and respond within ten (10) working days of receipt indicating either acceptance or rejection with required changes of the plan.
  - (iii) The Integrator is to address all comments and resubmit the plan within seven (7) working days after receiving the rejection notice and comments. The approved plan is to be used for all subsequent installations of similar equipment.
  - (iv) The Equipment Installation Plan is to include, but is not limited to, the following:
    - 1. Details of equipment to be used for installation
    - 2. Name, contact information and details of relevant experience of Integrator's personnel to be involved

3. Details and sequence of procedures to be employed for equipment installation
  4. Location, date and expected time of installation
  5. Details of precautionary measures to be adopted to avoid damage to the equipment
  6. Details of repair facilities/measures available to rectify any damage to the equipment during installation
- (f) Test Plan:
- (i) The Integrator is to submit a complete Test Plan to the Engineer for review and acceptance prior to commencing any testing. Allow sufficient time for this review such that it is accepted by the Engineer at least fourteen (14) days prior to the start any testing.
  - (ii) The Test Plan is to include details of the Pre-Construction Testing, Construction Phase Testing and Final Inspection and Acceptance Testing as specified in this special provision. In addition, the Test Plan is to address all material and equipment testing required by the contract documents.
  - (iii) The Test Plan is to include a schedule of each step of testing process; identification of all test equipment to be utilized; and identification of each independent testing Subcontractor to be employed to conduct specified testing.
- (g) Close Out Documentation: The Integrator is to provide the following items as part of the Close Out Documentation after construction has been completed.
- (h) Record Documents:
- (i) The Integrator is to maintain a set of record "As-Built" documentation and plans during the course of installation.
  - (ii) These documents are to be updated weekly by the Integrator to reflect current approved design changes and as-built information.
  - (iii) Completed record documents and plans are to be turned over to the Engineer at the completion of work.
  - (iv) Record Documents is to indicate, but not be limited to, the following:
    1. All approved changes and/or deviations from the contract documents
    2. Equipment model, serial number, and location
    3. ITS diagrams labeling all connections to equipment
    4. Maintenance and operation information adequate to operate all required features of all equipment without other technical support
    5. Service entrance facilities
    6. Main cross-connects
    7. Telecommunications closets, equipment rooms, handholes and manholes
    8. Splices
    9. Hand holes and junction boxes with their associated identifying label
    10. Location of all devices with device identification and cable routing

11. Other material and equipment as-built details required by the contract documents

(i) Application Software –

- (i) The Integrator is to provide necessary application software (including any applicable licenses) to allow the Department to edit diagram(s) as needed. If the Department has current software for managing this information, the Integrator is to use the Department's current standards in developing this information.

(j) Other Documentation:

- (i) The Integrator is to provide a graphical diagram of equipment connections on CD-ROM, and 8.5-inch by 11-inch paper copies indicating the Department identification and locations, as well as details of interconnection to other devices including media types.
- (ii) The Integrator is to provide complete ITS configuration, including any default settings modified on the ITS in both Microstation (.dgn) and Portable Document Format (.pdf) formats.
- (iii) The Integrator is to provide both bound and indexed paper medium and CD-ROM media documentation of all equipment and associated parts with manufacturer's nameplate, giving name of manufacturer, description, size, type, serial number, and other specifications per building, to facilitate maintenance or replacement. Nameplate of distributor or Contractor is not acceptable. These electronic file(s) is to be in Microsoft Access database format (.mdb). The Integrator is to provide two (2) sets of cable termination records for copper and fiber optic feed cables in a bound paper medium.
- (iv) One set is to be left on-site in each associated telecommunications closet or cabinet (in a water-tight resealable envelope), and the second set is to be provided to the Engineer upon project completion. Cross connect and patching information is to be filled out in pencil, to facilitate future changes.

**b. Materials.** The Integrator is to furnish new materials and equipment. Where no specific kind or quality of material is specified, the Integrator is to furnish industry standard materials, as approved by the Engineer.

1. Materials are to be produced by a company that has been engaged in the manufacture of such types of materials for a period of at least five (5) years. All equipment must be factory manufactured. All equipment is to come with a minimum three (3) year manufacturer's warranty.
2. The Integrator is to be responsible for protecting materials before, during, and after installation, until maintenance of the material is officially transferred to the Department. In event of damage, the Integrator is to make all repairs and/or replacement necessary to restore the material to its original state within the timeframe agreed upon with the Engineer and at no additional cost.

3. The Integrator is to supply the most recent version of all equipment hardware and software. A prior and/or old version of equipment, unless specifically identified as an exception to this requirement or approved by the Engineer, is not acceptable. In cases where a newer version of the equipment is available at the time of installation, the Integrator is to request a clarification from the Engineer on which equipment is to be used.
4. The Integrator is to deliver all material to the job site in original unopened containers, where applicable, with all labels intact and legible at time of use. The Integrator is to store all materials in accordance with manufacturer's recommendations and the accepted Materials Handling and Storage Plan.
5. The Integrator is to provide and install all available software upgrades through final acceptance. The exception is to be if such installation will compromise ITS functionality, subject to review and approval of the Engineer.
6. The Integrator is to furnish and install all patch cables to cross connect all available equipment. Patch cables are to be color-coded as follows:

	Patch Cable	Color
A. Telephone	Switch-to-Patch Panel	Gray
B. Telephone	Patch Panel-to-Patch Panel	Gray
C. Data	Server-to-Switch	Red
D. Data	Router/Switch/Other	Orange
E. Data	Hub-to-Switch	Yellow
F. Data	Hub-to-Hub	Green
G. Data	Hub-to-Patch Panel Workstation)	Blue
H. Data	Workstation-to-Wall	Blue/Gray/Beige

7. Transient voltages, surges, and sags are to not affect the equipment operations.
8. The equipment is to meet all the requirements in Section 2.1.4 - Power Interruption of the National Electrical Manufacturer's Association (NEMA) standard TSI for traffic control ITS and Section 2.1.6 - Transients, Power Service of the NEMA standard TSI.
9. The equipment is to be modular in design to allow major portions to be readily replaced in the field.
10. The equipment design and construction is to utilize the latest available techniques with a minimum number of different parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.
11. The equipment is to be designed for ease of maintenance. All equipment parts are to be readily accessible for inspection and maintenance. Test points are to be provided for checking essential voltages and waveforms.

12. All external screws, nuts, and locking washers are to be stainless steel. No self-tapping screws are to be used unless specifically approved by the Engineer. All parts are to be made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum, or brass. An inert dielectric material is to separate dissimilar metals.

13. Equipment Warranties:

- A. The Integrator is to provide a statement of warranty for all equipment and complete documentation of the procedures to initiate warranty service calls.
- B. Beginning with the date of notice to proceed and continuing for a period ending three (3) years after the date of acceptance by the Engineer, the Integrator is to provide the following services:
  - (1) The Integrator is to furnish a warranty of all hardware, software, and related equipment for the specific period of three (3) years from the date of final acceptance of work.
  - (2) All purchased hardware, equipment, and software is to have their ownership and warranties transferred to the Department. Where equipment is warranted for a period of less than three (3) years by its supplier or manufacturer, the Integrator is to buy an extended warranty from the manufacturer to complete the three (3) year warranty.
  - (3) When not available from the manufacturer, the Integrator is to extend the warranty to three (3) full years. The Department is to be the sole Owner of all equipment software or the registered licensee as appropriate.
  - (4) The Integrator is to pay for the cost of ownership or license of software during the warranty period.
- C. The Manufacturer is to repair any failed equipment covered by warranty that can be repaired on-site within 48 hours of notification of failure.
  - (1) The Integrator is to replace equipment requiring removal from site for repair or any equipment requiring replacement with a new unit within five (5) days of notification of failure.
  - (2) New replacement equipment is to continue the original warranty of the replaced unit except where the warranty provided by its supplier or manufacturer is longer. The cost of shipping of failed equipment is to be the responsibility of the Integrator.
  - (3) If equipment cannot be replaced with identical equipment, the Engineer is to provide approval after review of the Integrator's provided options.

**c. Construction.**

1. General Requirements:

- A. The Integrator is to optimize all hardware, firmware, and software settings to function, perform, and are managed via the communications network.

- B. The Integrator is to furnish, install, and properly configure software license programs as specified by manufacturer.
- C. The Integrator is to install, set in place, initialize, and configure all specified and/or included equipment for full and final operation.
- D. The Integrator is to provide full-featured operation of all ITS elements and demonstrate this operation to the Engineer by completion of all activities described in the accepted Test Plan.
- E. The Integrator is to comply with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations.
- F. The Integrator is to execute work in a manner which preserves and protects warranties of all equipment, whether or not the equipment is a part of this project.
- G. The Integrator is to ground and bond all equipment and materials as required by National and Local Standards, these Specifications, and as noted on the plans.
- H. The Integrator is to install all equipment such that the failure of any single equipment is not to cause the failure of any other equipment in the ITS.

2. Cutting and Patching:

- A. The Integrator is to complete all cutting and patching necessary for installation of work with approval of the Engineer.
- B. The Integrator is to use rotary type drilling tools and concrete cutting saws to cut concrete and masonry walls.
- C. The Integrator is to use rotary type drilling tools to cut cabinets where knock-outs are not available and cable access is required.
- D. The Integrator is to provide a firestop as required.
- E. The Integrator is to ensure waterproof holes through exterior walls and ground floor.
- F. The Integrator is not to impair strength or function of object being cut or patched, (e.g., do not weaken structural members).
- G. The Integrator is not to use a torch for cutting metal

3. Wiring Requirements:

- A. All wiring is to meet the requirements of the National Electric Code. All wires are to be cut to proper length before assembly.
- B. No wire is to be doubled-back to take up slack.



- C. Wires are to be neatly laced into cable with nylon lacing or plastic straps. Cables are to be secured with clamps.
- D. Service loops are to be provided at all connections.
- E. All DC relays, solenoids, and holding coils are to have diodes or other protective devices across the coils for transient suppression.
- F. The equipment is to contain readily accessible, manually resettable, or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.
- G. Circuit breakers or fuses are to be provided and sizes such that no wire, equipment, connector, PC board, or assembly is to be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.
- H. All external connections are to be made by means of connectors. The connectors are to be keyed to preclude improper hookups. All wires to and from the connectors are to be color-coded and appropriately labeled. In order to assure compatibility and performance compliance, the cables from the dome camera housing is to be assembled by the camera manufacturer.
- I. All pins and mating connectors are to be plated to provide good electrical connection and resist corrosion. Connectors utilizing solder type connections are to have each soldered connection covered by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.
- J. Modules of unlike functions are to be mechanically keyed to prevent insertion into the wrong socket or connector.
- K. All modules and assemblies are to be clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.
- L. Each control panel is to be one (1) integral unit with self-contained power supplies or is to draw its power from the camera controller.
- M. All external connections are to be made by means of connectors. The connectors are to be keyed to preclude improper hookups. All wires to and from the connectors are to be color-coded and/or appropriately marked. Pins and mating connectors are to be plated with a minimum of 20 microns of gold.
- N. Connecting harnesses of appropriate length and terminated with matching connectors are to be provided and installed for interconnection with the communications equipment interface.

4. Power Requirements:

- A. The equipment operation is not to be affected by the transient voltages, surges, and sags normally experienced on commercial power lines. It is the Integrator's responsibility to check the local power service to determine if any special design is needed for the equipment. The extra cost associated with any special design of the equipment to operate with local power service, if required, is to be included in the bid price.
- B. AC power cables are to be run separately from the communications signal cables.
- C. The equipment used is to be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- D. All electrical equipment is to meet all of its specified requirements when it is supplied from:
  - (1) 100 to 240 VAC, 50/60 Hz electricity for equipment with AC to DC switching power supplies.
  - (2) 120 VAC plus or minus 20%, 60 Hz plus or minus 3 Hz electricity for equipment with AC to DC wall power adapter.
- E. The equipment is to be powered from the output of an uninterruptible power supply (UPS). The maximum power required is not to exceed 300 watts.
- F. The Integrator is to comply with the working clearances and dedicated spaces per NEC Articles 110, 384, and 800-5, as well as all current NEC Articles, and Federal, State and Local regulations.
- G. The appropriate surge protector is to be installed to protect power conductor and control conductor (including return conductors).
- H. The equipment is to meet all the requirements of Section 2.1.6 -Transients, Power Service of the NEMA standard TSI.
- I. The ITS management software is to have the capability to detect when critical equipment experiences intermittent or permanent loss of power. The ITS management software is to identify the equipment that experienced the power loss.

5. Equipment Testing and Acceptance Requirements:

- A. The Integrator is to submit a complete Test Plan for the Engineer's review and acceptance prior to commencing any testing. If any modification to equipment is made, the Integrator is to repeat the testing according to the accepted Test Plan to ensure changes do not conflict with other equipment. Upon completion of any testing, written reports are to be submitted to the Engineer stating the results of the tests and any actions taken as a result of these tests.
- B. Payment schedules are to be dependent on the successful completion of these testing benchmarks (refer to individual equipment special provisions contained in the contract documents).

- C. All tests must be conducted in the presence of the Engineer.
- D. The Integrator is responsible for furnishing all test equipment required to test the ITS in accordance with the parameters specified. Unless otherwise stated, the test equipment is not to be considered part of the ITS. The Integrator is to furnish test equipment with greater accuracy than the parameters to be tested.
- E. All major and minor failures that occur and the corrective actions taken are to be maintained in a Failure Log, and provided to the Engineer. A record of failed equipment serial numbers are to be included in this log.
  - (1) A **major failure** is to be defined as having occurred if any one or more of the following occur: (Note: The 60-day test clock is to be reset to zero and restarted after major failures are corrected to the satisfaction of the Engineer.)
    - (a) Less than 95 percent of any individual ITS equipment is operational at any moment.
    - (b) Any failure that requires greater than 24 hours to correct.
    - (c) Frequent occurrence of minor failures indicating a major ITS flaw as determined by the Engineer.
  - (2) A **minor failure** is any other failure. The 60-day acceptance test period is to be stopped when a minor failure occurs and restarted without resetting to zero after the minor failure is corrected to the satisfaction of the Engineer.
- F. Pre-Construction Testing –
  - (1) Pre-Construction Testing is to provide the Engineer with a comprehensive proof of concept test demonstrating ITS equipment and components working interactively.
  - (2) The Integrator is to perform a comprehensive pre-test of the configuration and assembly details in the presence of the Engineer prior to any field installation. The procedures are to be as stated in the accepted Test Plan.
- G. Construction Phase Testing –
  - (1) After the Pre-Construction Test has been completed and 30 days prior to the anticipated date of acceptance of Construction Phase Testing, Construction Phase Testing is expected to begin.
  - (2) The Integrator is to verify in writing that the ITS equipment and components meet all of the requirements of the specifications and complies with all appropriate standards listed in these specifications.
  - (3) This testing is to be designed to validate that the ITS equipment and components works together to provide full ITS functionality prior to the Final Inspection and Acceptance Testing.
- H. Final Inspection and Acceptance Testing -
  - (1) The earliest of two (2) weeks prior to the final inspection or within sixty days of project completion, deliver to the Engineer four copies of a certificate by the authorized representative of the manufacturer that the ITS has been properly installed, adjusted and pre-tested.

- (2) At the Final Inspection, a representative of the equipment manufacturer is to demonstrate to the Engineer that the ITS functions as specified in the Plans and Special Provisions.
  - (3) There is to be an Acceptance Test period of 60 days after completion of the Final Inspection to identify, isolate, and correct any problems with the hardware, software, and interfaces. All problems discovered by the Integrator or Engineer are to be corrected to the satisfaction of the Engineer.
- I. Final Acceptance -
  - (1) Final acceptance of the complete and operating ITS will be made by the Engineer only after all of the following have been achieved.
  - (2) Successful completion of Acceptance Testing per the Test Plan that was accepted by the Engineer.
  - (3) Engineer receipt, review, and approval of all Acceptance Test data and results.
  - (4) Successful completion and delivery of all contract deliverables including all project documentation referenced in this or other special provisions.
  - (5) Field equipment is to operate continuously for 24 hours per day, seven (7) days a week for the duration of the 60-day acceptance test period, during which the equipment is to experience no major failures.
6. Equipment Identification:
  - A. Equipment is to be identified on each item with high quality, smear resistant, computer-generated labels, and established for logical identification in compliance with EIA/TIA 606, Specifications, or as directed by the Engineer. Labels are to be Brady or approved alternate and are to meet or exceed the legibility, defacement, and adhesion requirements specified in UL969, and meet or exceed the general exposure requirements in UL969 for indoor or outdoor use, whichever applies. Labeling identifiers are to be EIA/TIA 606 3.4. (Except jacks), followed by an identifying number or letter.
  - B. Each type of equipment, pathway, or space is to have a separate labeling scheme (e.g., there may be TC1, BC1, etc. within a building). Jacks are to be labeled with TC number, cabinet number, patch panel number, then port number unless noted otherwise (e.g., A-2-4-24 would be Closet A, Cabinet 2, patch panel 4, terminated on the 24th port; ensure all cabinets and patch panels are labeled accordingly).
  - C. Label plug-end of power cords identifying equipment powered.
7. Construction Site Cleanup:
  - A. The Integrator is to remove from the site all debris accumulating as a result of installation and properly dispose of all debris according to the standard specifications.
  - B. The Integrator is to leave all rooms, cabinets, and facilities in a clean condition.
  - C. The Integrator is to clean interiors of all cabinets, furniture, and equipment enclosures. The Integrator is to clean all equipment prior to acceptance testing. All equipment is to appear in new condition.

**d. Measurement and Payment.** The work included in this Special Provision, “Basic Materials and Methods for ITS Work”, is to be included in other pay items in other Special Provisions, and is not to be paid for separately.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**BACKBONE COMMUNICATIONS NETWORK**

DES: MM

1 of 23

03-15-2006

**a. Description.** This work is to consist of furnishing, mocking-up, installing, integrating and testing the primary communications network supporting the delivery of video image and data from and to the ITS field devices to and from the Michigan Intelligent Transportation Management Center (MITSC); this primary communications network is herein referred to as the Backbone Communications Network (BCN) equipment as depicted on the Plans. No additional items or payment other than what is indicated herein is required in this estimate of work. This work is to be done in accordance with the Michigan Department of Transportation 2003 Standard Specifications for Construction, except as modified. Items covered under this Special Provision include the following:

- A. Multi-port Terminal Servers (MTS) 16-port  
The MTS aggregates up to 16 serial data connections and provides communications to each serial port by way of Ethernet/IP;
- B. 10-Gig Ethernet Backbone Switch (10GigEBS)  
The 10GigEBS is a modular backbone switch providing 10Gbps, 1Gbps, 100Mbps, and 10Mbps Ethernet/IP connectivity via optical fiber or twisted pair copper conductor;
- C. Video Control Server (VCS)  
The VCS contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment;
- D. Communications Server (CS)  
The CS contains the necessary hardware and software to provide Ethernet/IP and serial connectivity between other system servers, client workstations, remote users and field devices in an Ethernet/IP network environment;
- E. Applications Server (AS)  
The AS contains the ATMS/ITS applications necessary to provide a user interface and the functionality required to support operating the system.
- F. Digital Video Encoder/Digital Video Decoder (DVE/DVD), Hardened  
The DVE encodes an analog video signal and a serial data signal (for PTZ) into an Ethernet/IP format. The DVD decodes the digital video stream from Ethernet/IP into an analog video signal and a serial data signal (PTZ); and
- G. Uninterruptible Power Supplies (UPS)  
The UPS provides uninterrupted power to critical equipment and systems.

2. Qualifications

- A. The proposed manufacturer of the Ethernet communications equipment contained within this Special Provision is required to demonstrate a minimum of three years experience in the Ethernet switch industry and recognized as an approved source of Ethernet switches by MDOT.
- B. The proposed Integrator of this BCN is required to demonstrate a minimum of three years project experience in the installation, integration, configuration, and setting up of Ethernet networks of similar size. The proposed Integrator is required to submit a list of project references including client project manager and contact information.

3. System Mock-up

- A. The MITSC ITS system is a 24/7 operations system, and to that end, MDOT is requiring a complete independent system mock-up and burn-in in an effort to reduce the amount of down-time created during the turn-up process of the proposed upgraded network.
- B. The Integrator must furnish, mock-up, install, integrate and test all equipment and components necessary to provide a full and complete Intelligent Transportation System (ITS) functional in all respects, without additional expense to the Department. The purpose of the mock-up is to configure, integrate, test and troubleshoot the system in an environment under controlled conditions prior to field deployment. The mock-up must include at a minimum all quantities of network components contained within this specification, plus a representative sample of each type of ITS device installation, existing and proposed, as depicted on the plans. Emulation of fiber optic insertion loss conditions using optical fiber attenuators are required. Prior to beginning the system mock-up, submit to the Engineer for approval an integration plan and mock-up schematics detailing the proposed configuration and acceptance test procedures that will take place in both the mock-up stage and the field deployment stage. Mock-up of the network and its devices must be held in an air conditioned facility equipped with all the necessary testing equipment for the proofing of each subsystem. Once configured and tested, the fully operational system will "burn-in" for 15 days, during which time the system will be exercised and monitored to assure that the system as configured meets the intended functional and performance requirements as contained within the Special Provisions. The Integrator is responsible, as an appurtenance to this Special Provision, for all expenses required to accomplish the required tasks, including but not limited to all travel expenses for four (4) MDOT inspectors or their representatives.

4. Summary

- A. The payment process including partial payment will be governed by Section 109 of the *Michigan Department of Transportation Construction Manual*.
- B. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the Integrator as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- C. The Integrator must furnish and install complete with all accessories the required communications pathways.
- D. BCN system switch-over and turn-up is required to be performed during weekend hours beginning on Friday at 9:00PM and ending on Monday at 5:00AM. In no case will the legacy network be dismantled until the proposed BCN is up and running uninterrupted for 168-hours. This requirement will enable the return to the legacy system if delays in the turn-up of the proposed BCN are encountered.

5. Requirements of Regulatory Agencies

The compliance with the latest edition of the following codes or standards is required:

- A. *National Television Systems Committee (NTSC)*
- B. *Moving Picture Experts Group (MPEG)*
- C. *Institute of Electrical and Electronic Engineers (IEEE)*
- D. *National Electrical Manufacturers Association (NEMA)*.
- E. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
- F. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
- G. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
- H. *Underwriters' Laboratories Standards 96 and 96A (UL).*

I. *American National Standards Institute Standard C2 (ANSI).*

6. General Requirements

- A. Furnish, assemble, fabricate or install materials that are new, corrosion resistant, and in accordance with the details shown on the Plans and in the Specifications.
- B. Install all the field equipment to be capable of operating in all weather conditions.
- C. Use identical and completely interchangeable equipment at each field location.
- D. Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- E. Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- F. All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

7. Functional Specifications

- A. The Backbone Communications Network must be implemented in a manner that will provide real-time traffic flow information and real-time video surveillance.
- B. The Backbone Communications Network must facilitate communication between the ITS field devices and the MITSC servers. All data detected by the ITS field devices must be transmitted on the wireless network and all data required by the ITS field devices must be received from the Backbone Communications Network. Any additional facilities (e.g., electronic equipment, cabling, or access to elevated equipment) which may be required to allow the equipment to work seamlessly across the entire network must be included in the work of this project and will not be paid separately. Any facilities or capabilities required to maintain connectivity throughout the network must be included in the work.
- C. The Backbone Communications Network must provide for resiliency and survivability of the data transmissions by utilizing standardized Ethernet protocols. These protocols must include Rapid Spanning Tree (IEEE 802.1w) and Resilient Packet Ring (IEEE 802.17) Standards.
- D. The Backbone Communications Network equipment must be interoperable. The most recent versions, patches, releases, license requirements, and related configuration options are all the responsibility of the Integrator through final acceptance.

8. Overview

- A. The equipment included in this Special Provision will provide communications between the Hubs and MITSC over existing fiber optic communications backbone as shown on the Plans. The Backbone Communications Network is the mechanism which allows the aggregation of all ITS field devices to exchange information and video with the MITSC.
- B. The Hub buildings are existing facilities, Hub 10, 9, 6, and 2, and are environmentally conditioned to support non-hardened equipment. The Integrator is required to furnish, mock-up, install, integrate and test the following Hub communications hardware and appurtenances at each Hub location as shown in the plans.
  - (1) One (1) 16-port Multi-port Terminal Server (MTS) per Hub;
  - (2) One (1) 10-Gig Ethernet Backbone Switch (10GigEBS) per Hub;
  - (3) Digital Video Encoders (DVE), quantity as noted within the Plans;
  - (4) DVE Rack with redundant power supplies, quantity as noted within the Plans;



- (5) One (1) Uninterruptible power supply;
- (6) All cables and patch cords required for a fully operation communications network; and
- (7) All power connections, including new circuits or power service if necessary.
- C. The MITSC, located at 1050 6th St., Detroit, MI 48226: Furnish, mock-up, install, integrate and test the following MITSC communications hardware and appurtenances as shown in the plans.
  - (1) One (1) 10-Gig Ethernet Backbone Switch (10GigEBS);
  - (2) One (1) Video Control Server;
  - (3) One (1) New ATMS Applications Server;
  - (4) One (1) New ATMS Communications Server;
  - (5) Digital Video Encoders (DVE), quantity as noted within the Plans;
  - (6) DVE Rack/s with redundant power supply/s, quantity as noted within the Plans;
  - (7) Digital Video Decoders (DVD), quantity as noted within the Plans;
  - (8) DVD Rack/s with redundant power supply/s, quantity as noted within the Plans;
  - (9) One (1) Uninterruptible power supply;
  - (10) All cables and patch cords; and
  - (11) All power connections, including new circuits or power service if necessary.
- D. The Integrator is required to provide operations and maintenance training courses for all MITSC operators and maintenance personnel for all components of the system.
- E. CCTV and ITS device control:
  - (1) CCTV video image transfer and PTZ control for legacy and proposed CCTV network must be controlled by way of the proposed Video Control Server and existing client workstations. The Video Control Server must be furnished, installed, integrated and tested with the necessary operating system software, video control software required for the control of IP Multicast video streams, and client software to be installed at each existing operator workstation (no more than 50).
  - (2) DMS, both legacy and proposed, must be controlled by way of the proposed Application and Communications Servers. The Application and Communications Servers must be furnished, installed, integrated and tested with the necessary operating system software, control software required for the control of the ITS devices shown on the plans, and client software to be installed at each existing operator workstation (no more than 50).

**b. Materials.**

- 1. Multi-Port Terminal Server (MTS)
  - (1) Technical Specifications
    - (1) Copper Port Specifications
      - (a) Sixteen (16) copper serial ports;
      - (b) One (1) copper fast Ethernet port;
      - (c) All ports must be Type RJ-45;
      - (d) The Ethernet 10/100 BASE-TX port is to auto negotiate for speed (10/100) and duplexity and must be compliant with standard *EIA/TIA-568-A, Commercial Building Telecommunications Cabling Standard*, pin-outs; and
      - (e) All Category 5e, shielded twisted pair (STP) network cables must be compliant with the *EIA/TIA-568-A*.
    - (2) Performance Specifications
      - (a) Ability of remote management features, including diagnostics, auto-discovery tool, data security via SSH v2 all ports simultaneously, SSLv3/TLSv1, port

buffering 64 Kbps per port, and full SNMP management. The SSLv3/TLSv1 must include support for AES 256-bit strong encryption as defined in IETF/RFC 3268 and FIPS 197.

- (b) DHCP, RARP, ARP-Ping, HTTP for ease of browser configuration, Telnet, Reverse Telnet, Rlogin and auto correct.
- (c) Allow up to 9 Telnet or Rlogin sessions per port and support TCP and UDP Socket.
- (d) Offer password access and DPA-Remote for ease of monitoring and firmware upgrades via TFTP with save/restore configuration to host.
- (e) Provide full control of serial parameters (DTR, DCD, DSR, CTS, RTS), baud rates (50-230400), parity (None, Even, Odd, Mark, Space), stop bits (1, 2). RTS toggle for half-duplex emulation must be supported.
- (f) Include forwarding/filtering rate of 14,880 packets per second (pps) for 10 Mbps and 148,800 pps for 100 Mbps.
- (g) Support, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).
- (h) Include simple network management protocol (SNMP), including MIBII and EIA-232 MIBS.
- (i) Have an operating system with Windows 2000, Windows XP, or Windows 2003 Server.
- (j) Have a minimum mean time between failures (MTBF) of 10 years.

(3) MTS Control Software

The Integrator must supply central control software for the multi-port terminal servers. The Integrator is responsible for installing, mocking up, integrating, and testing the MTS control software on the communication, application, and/or video control servers as required. The MTS control software must enable the following:

- (a) Local emulation of Unix TTP and Microsoft COM ports.
- (b) Transparent printing und UNIX.
- (c) Single TCP/IP connection per PortServer.
- (d) Encryption for heightened security.

(4) Mechanical Specifications

- (a) The equipment must operate and power must be supplied to the unit at 120 volts, 60 Hz (plus or minus 3Hz). The equipment must have a minimum operating input of 100 VAC and a maximum operating input of 240 VAC.
- (b) The unit is to contain diagnostic light emitting diodes (LEDs). These indicators is to include link, TX, RX, speed (for cat 5 ports only), and power LEDs.

(5) Environmental Specifications

The equipment must meet all specifications during and after being subjected to an operating ambient temperature range of 32 to 130°F, and with a non-condensing humidity of 5 to 95 percent.

2. 10 Gigabit Ethernet Backbone Switch (10GigEBS)

A. Summary

- (1) Provide a network of Ethernet switches located at the MITSC Hub locations identified in the plans; connected by a combination of copper and fiber cables. This section describes the furnishing, installation, integration and testing of the 10 Gigabit Ethernet Backbone Switches 10GigEBS).
- (2) The 10GigEBS's role is to aggregate Ethernet from the field/remote ITS Device Networks and interconnects multiple 10GigEBS over a switched 10 Gbps Ethernet Backbone. Further the 10GigEBS also must be furnished and integrated

in such a way as to provide switched 10/100/1000 Mbps connection over copper medium for links to users located at the Traffic Management Center (MITSC) and devices in or connected to the Communications Hubs.

C. Functional Requirements

- (1) Provide the 10GigEBS in a rack-mountable installation configuration and meet the specified requirements for a controlled office/equipment room temperature environment.
- (2) Provide a 10GigEBS with highly reliable, non-blocking, switched Ethernet data communications via optical fiber, Category 6 or Category 5e copper transmission medium at full wire speed.
- (3) Provide a 10GigEBS that is Certified NEBS Level 3 compliant.
- (4) Provide a display with the following diagnostic LED's for each port:
  - (a) LINK;
  - (b) TX;
  - (c) RX;
  - (d) SPEED; and
  - (e) DUPLEXITY.

D. Technical Requirements

- (1) Compliant with the following networking standards:
  - (a) IEEE 802.3 – 10BASE-T (Ethernet);
  - (b) IEEE 802.3u – 100BASE-TX/100BASE-FX (Fast Ethernet);
  - (c) IEEE 802.3x – Full Duplex and Flow Control;
  - (d) IEEE 802.3z – Gigabit Ethernet over Optical Fiber;
  - (e) IEEE 802.3ae – 10 Gigabit Ethernet;
  - (f) IEEE 802.1D – MAC Bridges (Spanning Tree Protocol);
  - (g) IEEE 802.1w – MAC Bridges (Amendment 2, Rapid Spanning Tree);
  - (h) IEEE 802.1Q – Virtual Bridged LAN (Port-Based VLAN);
  - (i) IEEE 802.1ad – Link Aggregation;
  - (j) IEEE 802.1p – Priority Queuing;
  - (k) IEEE 802.17 – Resilient Packet Ring;
  - (l) RFC 2236 IGMP v.2;
  - (m) RFC 2475 DiffServ;
  - (n) RFC 768 UDP;
  - (o) RFC 791 IP;
  - (p) RFC 792 ICMP;
  - (q) RFC 793 TCP;
  - (r) RFC 783 TFTP;
  - (s) RFC 826 ARP;
  - (t) RFC 854 Telnet;
  - (u) RFC 1157 SNMP v.1 and v.2;
  - (v) RFC 1213 MIB II;
  - (w) RFC 1493 Bridge MIB;
  - (x) RFC 1643 Ethernet MIB; and
  - (y) RMON 4.
- (2) Provide 10GigEBS that is modular in design (chassis and module). The chassis is to be capable of supporting multiple Ethernet interface modules.
  - (a) Minimum of six (6) slots.
  - (b) Minimum 400Gbps non-blocking backplane.
  - (c) EIA/TIA 19" Rack Mountable.
  - (d) Dual Auto-Switching/Hot-Swappable Power Supplies.
  - (e) Hot-swappable modules.

- (3) Provide, at a minimum, the following Ethernet and management ports for each 10GigEBS.
  - (a) Optical port requirements:
    - (i) A minimum of four (4) 10Gig slots for 10Gig optical modules; and
    - (ii) A minimum of two (2) 10GBASE-ER 1550nm (up to 40km) optical transceiver modules. If higher power transceiver modules are necessary in order to provide uplink connectivity between one 10GigEBS to another, these will be upgraded by the Integrator at no additional expense to the Department. Connector Type SC or LC.
  - (b) Copper port requirements:
    - (i) Forty-eight (48) copper ports for all 10 Gig EBS in each Hub
    - (ii) Ninety-six (96) copper ports for the 10 Gig EBS at the MITSC.
    - (iii) Type RJ45.
    - (iv) Auto-negotiate for speed (10/100/1000) and duplexity (Full or Half) for each port.
  - (c) Management Port
    - (i) May reside on its own module, or as part of one of the modules provided under this special provision
    - (ii) Type RJ45, RJ11, or DB-9
    - (iii) Management cable must be provided by the manufacturer.
- (4) Support Full Layer 2 and Layer 3 Management/Routing features. These include, but are not limited to:
  - (a) IEEE 802.1D – MAC Bridges;
    - (i) Spanning Tree Protocol.
    - (ii) Meet or exceed the STP Healing rate that is published by the IEEE 802.1D Standard.
  - (b) IEEE 802.1w – MAC Bridges, Amendment 2;
    - (i) Rapid Spanning Tree Protocol.
    - (ii) Meet or exceed the RSTP Healing that is published by the IEEE 802.1w Standard.
  - (c) IEEE 802.1Q – Virtual Bridged LAN;
    - (i) Port Based VLAN.
    - (ii) Meet or exceed that published by the IEEE 802.1Q Standard.
    - (iii) Minimum 4K VLAN address table required.
  - (d) IEEE 802.17 – Resilient Packet Ring;
    - Meet or exceed the RPR recovery time published by the IEEE 802.17 Standard.
  - (e) Forwarding/Filtering Rate;
    - (i) 14,880 pps (packets per second) for 10Mbps.
    - (ii) 148,800 pps for 100 Mbps.
    - (iii) 1,488,000 pps for 1 Gbps.
    - (iv) 14,880,000 pps for 10Gbps.
  - (f) MAC Address Table;
    - Minimum 4K MAC address table.
  - (g) UDP
    - (i) Must support User Datagram Protocol.
    - (ii) RFC 768.
  - (h) TCP/IP
    - (i) Must support Transmission Control Protocol/Internet Protocol v.4 or higher.
    - (ii) RFC 791 and RFC 793.

- (i) IGMP Support;
    - (i) Must support Internet Group Management Protocol v. 2 or higher.
    - (ii) RFC 2236.
  - (j) SNMP Support;
    - Must support SNMP v.1 and v.2 management.
  - (k) Access via resident RS-232 management port; and
    - (i) Access via telnet or ftp.
    - (ii) RFC 1157, RFC 854, RFC 783.
  - (l) RMON/SMON Support;
    - (i) Must support RMON for Ethernet Agent v.4.
    - (ii) Must have the capability to upgrade to SMON if required.
  - (m) FTP Support;
    - (i) Must support File Transfer Protocol.
    - (ii) RFC 783.
  - (n) NTP/SNTP Support.
    - (i) Must support Network Time Protocol/Simple Network Time Protocol.
    - (ii) NTP/SNTP Support.
  - (o) QoS Support
    - (i) Must support Quality of Service configurations.
    - (ii) Must use or be compatible with DiffServ Protocol.
    - (iii) RFC 2475.
  - (p) MPLS Support
    - (i) Must support Multi Protocol Label Switching traffic engineering
    - (ii) RFC 2702
    - (iii) Framework for IP Multicast in MPLS
    - (iv) RFC 3353
  - (q) OSPF Support
    - (i) Must support Open Shortest Path First protocol.
    - (ii) RFC 2328.
  - (r) PIM Support
    - (i) Must support Protocol Independent Multicasting.
    - (ii) Sparse Mode (PIM-SM)
    - (iii) Version 2 or most recent
    - (iv) RFC 2362.
  - (5) The 10GigEBS is to contain ample memory (volatile and non-volatile) for storage of tables and data including, but not limited to:
    - (a) MAC Address.
    - (b) Boot Program.
    - (c) OS Program.
    - (d) Management Program.
    - (e) Logs.
  - (6) Boot, OS and Management programs must be upgradeable and backwards compatible with older versions. The user must be able to perform upgrades via console, telnet or ftp.
- E. Error/Failure Requirements
- (1) Log in every Error or Failure in an error log.
  - (2) The error log must be downloaded, saved or exported to basic text format.
  - (3) Manufacturer must have tested and certified by Bellcore/Telcordia Standard a Mean Time Between Failure (MTBF) of minimum 10 years.
  - (4) All materials and appurtenances must meet the specified requirements for controlled office/equipment room temperature environment. Specifically,

operating temperature range must be between 0°C and +40°C and humidity must be between 0% and 85% (Non-Condensing).

F. Cable Requirements

- (1) Provide all power, data, and video cables for the display cubes, and controller, including a cable linking the controller to each of the inputs shown in the Plans.
- (2) Forty-eight (48) Category 5e Ethernet patch cords for each 10GigEBS;
  - (a) Made to length (not to exceed 150 feet).
  - (b) Pinned straight through.
  - (c) 24 gauge, 4-pair conductor.
  - (d) RJ-45 snagless connectors.
  - (e) Certified for 100MHz operation.
  - (f) Blue in color.
- (3) Four (4) single mode fiber optic patch cords;
  - (a) Made to length (not to exceed 150 feet).
  - (b) Duplex patch cords.
  - (c) Connectorized to mate to 10 Gigabit optics and passive optical network.
  - (d) Yellow in color.
- (4) One (1) management cable for each switch;
  - (a) DB-9 Male to correct type of port .
  - (b) One (1) meter in length.

G. Field Quality Control

Develop a detailed test plan for the each 10GigEBS and the 10Gig Ring and revise it until it meets the Owner's approval. The plan must include:

- (1) Visual inspection of wiring.
- (2) Execution of all diagnostic routines provided by the manufacturer.
- (3) Execution of a graduated testing process. The process must begin from the field side and work up each level of the communications system. Each link must be tested in accordance with RFC 2544, RFC 3393 and RFC 1242. Tests must measure at a minimum:
  - (a) Back-to-back Packet Testing;
  - (b) Throughput;
  - (c) Burstability;
  - (d) Latency ;
  - (e) Frame Loss; and
  - (f) Packet Jitter (frame-delay variation).
- (4) Demonstration that the switch connects to the field, center, and/or communications network as defined in the specifications, plan sets, or as directed by the Engineer and is fully functional in keeping with the specifications
- (5) Conduct the approved tests and report the results in writing to the Owner's representative.

3. Video Control Server (VCS)

A. Summary

- (1) The VCS contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment.
- (2) The VCS must be furnished, installed, integrated and tested to accomplish the functional and performance requirements contained within this special provision.

B. Functional and Performance Requirements

- (1) The materials used and workmanship completed by the Integrator must be in accordance with the most recently accepted and approved industry standards. All materials, equipment, supplies, installations, and testing must comply with the

project requirements, the latest editions of the following standards, as applicable, and any other applicable standards and requirements:

- a. International Organization for Standardization;
  - b. American Society of Testing and Materials (ASTM);
  - c. Institute of Electrical and Electronic Engineers (IEEE);
  - d. American National Standards Institute (ANSI);
  - e. National Electrical Manufacturers' Association (NEMA);
  - f. Underwriters' Laboratories, Inc. (UL);
  - g. National Board of Fire Underwriters;
  - h. Electrical Testing Laboratories (ETL);
  - i. Telcordia (formerly Bellcore) technical advisories and requirements;
  - j. Electronic Industries Association (EIA);
  - k. National Electrical Code (NEC);
  - l. American Standard Code for Information Interchange (ASCII);
  - m. International Telecommunications Union (ITU);
  - n. Telecommunications Industries Association (TIA);
- (2) The VCS must operate commercial off-the-shelf (COTS) software. The server must be designed for 24/7 operation. The Integrator must furnish and install one VCS in the MITSC, located at 1050 6th St., Detroit, MI 48226. All installation must be coordinated with the Engineer and with the MITSC IT/IS Manager.
  - (3) The VCS must execute the Microsoft Windows Server 2000 operating system with the capability to migrate to Windows Server 2003.
  - (4) The VCS must execute the 360 Surveillance Cameleon ITS, Advanced ITS Software. Provide 50 User Licenses for use by MDOT Metro Region. The software must support simultaneous NTCIP and non-NTCIP control of the CCTV cameras, existing and proposed. The software must support NTCIP DMS control of the proposed Dynamic Message Signs. The software must manage the join and leave commands of IP Video Multicasting.
  - (5) Provide, as an appurtenance to the VCS, client software required to provide video switching, viewing and control at all existing control room workstations. The client software shall also allow any user at any workstation to display any selected video stream (both existing and proposed) to any selected video monitor or output.
  - (6) The VCS must use dual (Qty. 2) Intel Xeon 3.6 Gigahertz processor with an 800 Megahertz Front Side Bus and at least 2 Megabytes of level 2 cache. The server must include at least 4 Gigabytes of DDR (Double Data Rate) Dynamic Random Access Memory operating at 400 Megahertz or greater with an additional at least 1 Gigabyte expansion kit on two 512 Megabyte DIMMs.
  - (7) Storage devices must be factory-installed within the server housing and must include read-only compact disk (CD-ROM) and hard disk devices. The hard disks must be 3 or more 15,000 RPM hard drives connected through a PCI, embedded or on-board RAID hard drive controller (PERC4 or Ultra3 SCSI). Controller must have a minimum 128Mb Cache. Each hard drive will have a capacity of 146 Gigabytes or greater. The CD-ROM drive must be 24X or faster.
  - (8) The VCS must include networking and interface ports for both operational and maintenance use. Networking must be provided by dual self-detecting 10/100/1000 RJ-45 ports operating standards-compliant Ethernet. Each server must have one (1) standard 9-pin RS-232 serial port configurable between a minimum of at most 1200 bits per second and a maximum of at least 115,000 bits per second. Each server must provide one point-device (mouse) interface, one monitor interface (RGB 15-pin of at least VGA resolution), one (1) standard 6-pin keyboard interface, and at least 2 USB 2.0 ports. Two of the servers to be installed

at the TMC must include 56K data modems. The modems must be internal on PCI 2.2 cards that can be accommodated by the server housing with V.90 or later compatibility and MNP10 or better error correction. Each modem card must be capable of connecting to at least one standard RJ-11 analog telephone line using the AT command set.

- (9) The VCS must be rack-mountable in a standard 19-inch equipment rack requiring no more than 2U of rack space and weigh no more than 70 lbs. The server housing must accept a minimum of three (3) full size PCI-X cards. The equipment must operate on and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC or less and a maximum operating input of 132 VAC or greater. The maximum power consumption must be 575 Watts for each server. Each server must have hot pluggable redundant power supplies (both NEMA and IEC cords) and hot pluggable redundant ventilation fans.
  - (10) Install the VCS in existing rack space. If additional rack space is required, the Integrator is responsible for furnishing and installing said rack.
  - (11) Provide a 19" rack mounted, 2U maximum, slide out keyboard, video, and mouse (KVM) switch with serial port capability able to control all servers contained within this special provision plus at least one spare port.
  - (12) Except as stated otherwise herein, within the plan set, and/or in the Contract, the servers must meet all specifications during and after being subjected to an ambient operating temperature range of 10° to 35° Celsius (C) at sea level and a non-condensing relative humidity of 10% to 90%. The acceptable ranges for shipment and storage are -40° - 70° C and 5% - 95% relative humidity. The design must be inherently temperature compensated to prevent abnormal operation. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.
4. Communications Server (CS)
- A. Summary
    - (1) The CS contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment.
    - (2) The CS must be furnished, installed, integrated and tested to accomplish the functional and performance requirements contained within this special provision.
  - B. Functional and Performance Requirements
    - (1) The materials used and workmanship completed by the Integrator must be in accordance with the most recently accepted and approved industry standards. All materials, equipment, supplies, installations, and testing must comply with the project requirements, the latest editions of the following standards, as applicable, and any other applicable standards and requirements:
      - a. International Organization for Standardization;
      - b. American Society of Testing and Materials (ASTM);
      - c. Institute of Electrical and Electronic Engineers (IEEE);
      - d. American National Standards Institute (ANSI);
      - e. National Electrical Manufacturers' Association (NEMA);
      - f. Underwriters' Laboratories, Inc. (UL);
      - g. National Board of Fire Underwriters;
      - h. Electrical Testing Laboratories (ETL);
      - i. Telcordia (formerly Bellcore) technical advisories and requirements;
      - j. Electronic Industries Association (EIA);
      - k. National Electrical Code (NEC);



- l. American Standard Code for Information Interchange (ASCII);
  - m. International Telecommunications Union (ITU);
  - n. Telecommunications Industries Association (TIA);
- (2) The CS must operate commercial off-the-shelf (COTS) software. The server must be designed for 24/7 operation. The Integrator must furnish and install one CS in the MITSC, located at 1050 6th St., Detroit, MI 48226. All installation must be coordinated with the Engineer and with the MITSC IT/IS Manager.
  - (3) The CS must execute the Microsoft Windows Server 2000 operating system with the capability to migrate to Windows Server 2003.
  - (4) Provide, as an appurtenance to the CS, client/server software required to manage the communications between the central system and the existing and proposed ITS devices over the proposed 10Gigabit Ethernet Network.
  - (5) The CS must use one Intel Xeon 3.6 Gigahertz processor with an 800 Megahertz Front Side Bus and at least 1 Megabyte of level 2 cache. The server must include at least 1 Gigabyte of Dynamic Random Access Memory operating at 400 Megahertz or greater with an additional at least 1 Gigabyte expansion kit on two 512 Megabyte DIMMs.
  - (6) Storage devices must be factory-installed within the server housing and must include read-only compact disk (CD-ROM) and hard disk devices. The hard disks must be 3 or more 10,000 RPM hard drives connected through SCSI to a Hewlett-Packard Smart Array 6i or equivalent hard drive controller. Each hard drive will have a capacity of 72.8 Gigabytes or greater. The CD-ROM drive must be 24X or faster.
  - (7) The CS must include networking and interface ports for both operational and maintenance use. Networking must be provided by dual self-detecting 10/100/1000 RJ-45 ports operating standards-compliant Ethernet. Each server must have one (1) standard 9-pin RS-232 serial port configurable between a minimum of at most 1200 bits per second and a maximum of at least 115,000 bits per second. Each server must provide one point-device (mouse) interface, one monitor interface (RGB 15-pin of at least VGA resolution), one (1) standard 6-pin keyboard interface, and at least 2 USB 2.0 ports. Two of the servers to be installed at the TMC must include 56K data modems. The modems must be internal on PCI 2.2 cards that can be accommodated by the server housing with V.90 or later compatibility and MNP10 or better error correction. Each modem card must be capable of connecting to at least one standard RJ-11 analog telephone line using the AT command set.
  - (8) The CS must be rack-mountable in a standard 19-inch equipment rack requiring no more than 2U of rack space and weigh no more than 70 lbs. The server housing must accept a minimum of three (3) full size PCI-X cards. The equipment must operate on and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC or less and a maximum operating input of 132 VAC or greater. The maximum power consumption must be 575 Watts for each server. Each server must have hot pluggable redundant power supplies (both NEMA and IEC cords) and hot pluggable redundant ventilation fans.
  - (9) Install the CS in existing rack space. If additional rack space is required, the Integrator is responsible for furnishing and installing said rack.
  - (10) Provide a 19" rack mounted, 2U maximum, slide out keyboard, video, and mouse (KVM) switch with serial port capability able to control all servers contained within this special provision plus at least one spare port.

- (11) Except as stated otherwise herein, within the plan set, and/or in the Contract, the servers must meet all specifications during and after being subjected to an ambient operating temperature range of 10° to 35° Celsius (C) at sea level and a non-condensing relative humidity of 10% to 90%. The acceptable ranges for shipment and storage are -40° - 70° C and 5% - 95% relative humidity. The design must be inherently temperature compensated to prevent abnormal operation. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.

## 5. Applications Server (AS)

### A. Summary

- (1) The AS contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment.
- (2) The AS must be furnished, installed, integrated and tested to accomplish the functional and performance requirements contained within this special provision.

### B. Functional and Performance Requirements

- (1) The materials used and workmanship completed by the Integrator must be in accordance with the most recently accepted and approved industry standards. All materials, equipment, supplies, installations, and testing must comply with the project requirements, the latest editions of the following standards, as applicable, and any other applicable standards and requirements:
  - a. International Organization for Standardization;
  - b. American Society of Testing and Materials (ASTM);
  - c. Institute of Electrical and Electronic Engineers (IEEE);
  - d. American National Standards Institute (ANSI);
  - e. National Electrical Manufacturers' Association (NEMA);
  - f. Underwriters' Laboratories, Inc. (UL);
  - g. National Board of Fire Underwriters;
  - h. Electrical Testing Laboratories (ETL);
  - i. Telcordia (formerly Bellcore) technical advisories and requirements;
  - j. Electronic Industries Association (EIA);
  - k. National Electrical Code (NEC);
  - l. American Standard Code for Information Interchange (ASCII);
  - m. International Telecommunications Union (ITU);
  - n. Telecommunications Industries Association (TIA);
- (2) The AS must operate a commercial off-the-shelf (COTS) software. The server must be designed for 24/7 operation. The Integrator must furnish and install one AS in the MITSC, located at 1050 6th St., Detroit, MI 48226. All installation must be coordinated with the Engineer and with the MITSC IT/IS Manager.
- (3) The AS must execute the Microsoft Windows Server 2000 operating system with the capability to migrate to Windows Server 2003.
- (4) Provide, as an appurtenance to the AS, client/server software required to provide the necessary management, monitoring, and control of the proposed ITS devices.
- (5) The AS must use one Intel Xeon 3.6 Gigahertz processor with an 800 Megahertz Front Side Bus and at least 1 Megabyte of level 2 cache. The server must include at least 1 Gigabyte of Dynamic Random Access Memory operating at 400 Megahertz or greater with an additional at least 1 Gigabyte expansion kit on two 512 Megabyte DIMMs.

- (6) Storage devices must be factory-installed within the server housing and must include read-only compact disk (CD-ROM) and hard disk devices. The hard disks must be 3 or more 10,000 RPM hard drives connected through SCSI to a Hewlett-Packard Smart Array 6i or equivalent hard drive controller. Each hard drive will have a capacity of 72.8 Gigabytes or greater. The CD-ROM drive must be 24X or faster.
  - (7) The AS must include networking and interface ports for both operational and maintenance use. Networking must be provided by dual self-detecting 10/100/1000 RJ-45 ports operating standards-compliant Ethernet. Each server must have one (1) standard 9-pin RS-232 serial port configurable between a minimum of at most 1200 bits per second and a maximum of at least 115,000 bits per second. Each server must provide one point-device (mouse) interface, one monitor interface (RGB 15-pin of at least VGA resolution), one (1) standard 6-pin keyboard interface, and at least 2 USB 2.0 ports. Two of the servers to be installed at the TMC must include 56K data modems. The modems must be internal on PCI 2.2 cards that can be accommodated by the server housing with V.90 or later compatibility and MNP10 or better error correction. Each modem card must be capable of connecting to at least one standard RJ-11 analog telephone line using the AT command set.
  - (8) The AS must be rack-mountable in a standard 19-inch equipment rack requiring no more than 2U of rack space and weigh no more than 70 lbs. The server housing must accept a minimum of three (3) full size PCI-X cards. The equipment must operate on and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC or less and a maximum operating input of 132 VAC or greater. The maximum power consumption must be 575 Watts for each server. Each server must have hot pluggable redundant power supplies (both NEMA and IEC cords) and hot pluggable redundant ventilation fans.
  - (9) Install the AS in existing rack space. If additional rack space is required, the Integrator is responsible for furnishing and installing said rack.
  - (10) Provide a 19" rack mounted, 2U maximum, slide out keyboard, video, and mouse (KVM) switch with serial port capability able to control all servers contained within this special provision plus at least one spare port.
  - (11) Except as stated otherwise herein, within the plan set, and/or in the Contract, the servers must meet all specifications during and after being subjected to an ambient operating temperature range of 10° to 35° Celsius (C) at sea level and a non-condensing relative humidity of 10% to 90%. The acceptable ranges for shipment and storage are -40° - 70° C and 5% - 95% relative humidity. The design must be inherently temperature compensated to prevent abnormal operation. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.
6. Digital Video Encoder/Digital Video Decoder (DVE/DVD), Hardened
- A. Summary
- (1) Provide Moving Picture Experts Group (MPEG-4) video compression and decompression technology at minimum rates of 20 frames per second (FPS) at Common Intermediate Format (CIF) at a speed of 384 Kilobits per second (Kbps) to a maximum 30 frames per second (FPS) at 3 Megabits per second (Mbps). This ITS device encodes (i.e., digitize) analog video at the closed-circuit television (CCTV) surveillance system remote site/s as well as simplex/duplex bi-directional data sub-

channels, and upon commands from the MITSC operators, delivers the selected IP addressed video and data to that sites network interface device (i.e., the Managed Ethernet switch), which transmits and receives data streams to, and from, the transportation management center (MITSC), also known as the network head-end, by way of the communications hub/s and/or the communications node/s interconnected to the remote surveillance system(s).

(2) Units contained in this special provision must be installed in existing MDOT Hubs or the MITSC.

**B. Functional and Performance Requirements**

- (1) The compliance with the latest edition of the following codes or standards is required:
  - a. National Television Systems Committee (NTSC);
  - b. Moving Picture Experts Group (MPEG);
  - c. Institute of Electrical and Electronic Engineers (IEEE);
  - d. National Electrical Manufacturers Association (NEMA);
  - e. National Fire Protection Association (NFPA) 70 - National Electrical Code;
  - f. National Fire Protection Association (NFPA) 780 - Lightning Protection Code;
  - g. Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177;
  - h. Underwriters' Laboratories Standards 96 and 96A (UL); and
  - i. American National Standards Institute Standard C2 (ANSI).
- (2) Furnish, assemble, fabricate or install materials that are new, corrosion resistant, and in accordance with the details shown on the Plans and in the Specifications.
- (3) Install all the field equipment to be capable of operating in all weather conditions.
- (4) Use identical and completely interchangeable equipment at each field location.
- (5) Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- (6) Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- (7) All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.
- (8) Transmit compressed digital video and one bi-directional data channels over Internet Protocol (IP) networks.
- (9) Employ the compression algorithms contained in the MPEG-4 technology according to the International Organization for Standardization (ISO) and International Electrotechnical Commission's requirements as detailed in the *ISO/IEC 14496-2:1999* standard for MPEG-4 technology.
- (10) Operate at a minimum of a Common Intermediate Format (CIF) resolution of 20 FPS, and at a maximum of a full D1 resolution of 30 FPS.
- (11) Support both NTSC and PAL.
- (12) Include on-board buffered video memory for protection against potential network disruptions.
- (13) Contain an embedded operating system to provide distributed video processing and support through open network standards.
- (14) Allow vendor interoperability through embedded universal translation.
- (15) Not exceed 250 milliseconds of latency.
- (16) The data sub-channels must be software programmable, directly or over the network, as defined by the Electronic Industries Alliance (EIA) for the

- EIA-232/422/485 data format, data rate, and data structure (e.g., the number of bits, parity, stop bits, etc.), and IP addressable.
- (17) The network connection must be Ethernet Compliant IEEE 802.3, 802.3u, and 802.3x; 10/100 Mbps, static or DHCP, auto sensing full/half duplex and compatible by way of a Registered Jack (RJ)-45 connector, allowing transmissions over a Category 5e cable to an attached fiber optic media converter, an Ethernet switch, or an IP wireless device.
  - (18) The module must be available in card mount and surface mount versions and provide automatic reset as well as transient suppression on all video, data and contact closure input/output connections.
  - (19) Digital Video Encoders and Digital Video Decoders required and depicted within the Plans must be provided with a communications management chassis (rack) and redundant power supplies. The rack quantities are as noted within the Plans.
  - (20) All Digital Video Encoders (DVE) and Digital Video Decoders (DVD) included within this project and/or contained within the local ITS Device Communications Network or the Primary Ethernet Backbone Communications Network must be from the same manufacturer and fully interoperable without customization or the addition of appliances within either the remote or primary communications network.
  - (21) The DVE/DVDs must be equipped with binary network connectors (BNCs) and in compliance with the NTSC standard resolution listed below:
    - a. D1 NTSC 720 horizontal x 480 vertical; D1 PAL 720 horizontal x 576 vertical;
    - b. 4CIF NTSC 704 horizontal x 480 vertical; 4CIF PAL 704 horizontal x 576 vertical;
    - c. 2CIF NTSC 704 horizontal x 240 vertical; 2CIF PAL 704 horizontal x 288 vertical;
    - d. CIF NTSC 352 horizontal x 240 vertical; CIF PAL 352 horizontal x 288 vertical.
  - (22) Video Input Specifications
    - a. The video input performance measures must comply with NTSC and EIA requirements, including the EIA-170 standard, with a composite video of 1.0 to 1.2 volt peak-to-peak (Vp-p).
    - b. The equipment must have an electrical resistance of 75 ohms ( $\Omega$ ) per 60 hertz (Hz).
  - (23) Data Input/Output Specifications
    - a. All data ports must be compliant with standard EIA-232/422/485 data format. The port's handshaking feature must be software selectable and the data transmission rate of 19.2 kilobytes per second for RS-422/485 and 115.2 Kilobytes per second for RS-232.
    - b. The serial data output must comply with EIA-232/422/485 data format requirements, and must be software selectable.
  - (24) Output Local Area Network (LAN) Connection Specifications
    - a. The device output connection must be Category 5e shielded twisted pair (STP) network cables and must be compliant with the EIA and Technology Industries Association's (TIA) requirements as detailed in the *EIA/TIA-568-A standard*.
    - b. The device's output connector port must be Type RJ-45.
    - c. All Category 5 ports must be standard *EIA/TIA-568-A* pin-outs and must be rated at 10/100 Mbps.
  - (25) Indicator/Display Specifications

- a. Two-line scrolling displays or another means of visible, device operational, information dissemination.
- (26) Network Parameter Specifications
  - a. A minimum data transfer rate of 385 Kbps adjustable to an upper limit of 4.0 Mbps is required.
  - b. The 10/100BASE-TX, as required in the IEEE 802.3 standards and amendments, must be the network connection to the network devices with Type RJ-45 connectors.
  - c. Conform to Version 4 of the User Datagram Protocol (UDP), Version 2 of the Internet Group Management Protocol (IGMP), and TCP/IP Version 4.
  - d. Require the following network protocols: Unicast/Multicast, DiffServ (QoS), UDP, TCP, IP, HTTP, RTSP, RTCP, Telnet, IGMP 2.0, ICMP, DHCP, SNMP, and RTP.
- (27) Mechanical Specifications
  - a. 120 volts power (plus or minus 10 percent) of alternating current (VAC) must be supplied to the unit. If the device requires operating voltages of less than 120 VAC, the Integrator must supply the appropriate voltage converter. The maximum power consumption of any DVE/DVD is 15 watts.
- (28) Environmental Specifications
  - a. Have a minimum ambient operating temperature range of -40 to 164.2° Fahrenheit (°F) [-40 to 74° Celsius (C)], the non-condensing relative humidity between 0 to 95 percent, and the temperature inherently compensated to prevent abnormal operation.
  - b. All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.
  - c. Exceed NEMA TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for Operating Temperature, Humidity, Mechanical Shock, Vibration, and Voltage Transient Protection.
- C. Equipment
  - (1) The DVE/DVD's power connection is through the output of the uninterruptible power supply (UPS).
  - (2) Testing must be as per Manufacturer and in compliance with the Project Acceptance Test Plan.
- 7. Uninterruptible Power Supply (UPS)
  - A. Summary
    - (1) The individual UPS units must allow for battery back up or standby power for specific ITS devices as noted within the plan set or by the Engineer.
  - B. Functional and Performance Requirements
    - (1) The UPS must be capable of operating within an environment with an ambient temperature of -37C° to +74C°.
    - (2) The UPS must have advanced logging/programming capability, real-time status reporting, and fully programmable dry contacts.
    - (3) The UPS dimensions must be 17-inches wide, by 5.25-inches high, by 11-inches deep, nominal
    - (4) Provide an UPS that is mountable inside a standard EIA 19" Rack.
    - (5) Power Delivery

- a. The Hardened UPS must be capable of delivering standby power at 120 volts, with an output power rating of 1250 VA, to the plan set specified ITS device within 60 microseconds after the loss of regular power.
  - b. The UPS must maintain power to the ITS device for a period of 118 minutes at 25C° ambient temperature when the ITS device has a power requirement of 450 watts.
- (6) The UPS must have the following features:
- a. Local Keypad programmability;
  - b. Backlit LCD display;
  - c. Six fully programmable dry contacts;
  - d. Remote access via RS-232 serial;
  - e. Provides fully interactive program and status reporting;
  - f. Time/Date Stamp of events and alarms;
  - g. Field upgradeable from 1250 VA to 2000 VA;
  - h. Fits in all types of traffic enclosures or can be mounted in an electrical service or custom pedestal;
  - i. Low harmonic AC sinewave output;
  - j. Fully programmable AC threshold voltages; ie. NEMA, Caltrans, or Custom;
  - k. External connections are front panel accessible;
  - l. Form C dry relay contacts close on low battery;
  - m. LED indicator for online, on battery, low battery, overload and fault;
  - n. RS-232 serial interface;
  - o. Intelligent Boost Operation for brownout;
  - p. Option power conditioning;
  - q. Back up power provide by sealed battery modules;
  - r. Temperature-concentrated charging;
  - s. Noise suppression, FCC Class A; and
  - t. Meets Caltrans BBS specifications.
- (7) Electrical
- |  |                        |
|--|------------------------|
| a. Input/Output Voltage (VAC) nominal  | 120                    |
| b. Input/Output Frequency (Hz) nominal | 60                     |
| c. Input Current (A) maximum           | 12/20                  |
| d. Input Voltage Variation             | -23% to +17%           |
| e. Voltage Waveform                    | Sine                   |
| f. Typical Line Efficiency             | 95%-97%                |
| g. Typical Output Voltage THD          | <3%                    |
| h. Maximum Charge Current (ADC)        | 6/10                   |
| i. Maximum Transfer Time (ms)          | 60                     |
| j. Audible Noise at 1m (dBA)           | <32                    |
| k. Lightning/Surge Protection          | ANSI C.62.45 Cat A & B |
- (8) Environmental
- a. Except as stated otherwise herein, within the plan set, and/or in the Contract, the UPS must meet all specifications during and after being subjected to an ambient operating temperature range of -34° to +74° Celsius (C) and a non-condensing relative humidity of 0 to 90 percent.
  - b. The design must be inherently temperature compensated to prevent abnormal operation.
  - c. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.
- (9) Mechanical

- a. All external screws, nuts, and locking washers must be stainless steel.
- b. The Integrator must not use self-tapping screws unless the Engineer provides prior approval.
- c. All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

**c. Construction.**

**1. General Requirements**

- A. Prior to shop drawings, a pre-construction site survey must be conducted by a factory trained and certified representative. The site survey is designed to identify the exact locations and details for each installation. The site survey report must be submitted to the Engineer for approval including specific location and detail information before commencement of work.
- B. Coordinate with local utility companies to move, add, change or delete services as required to facilitate a timely, cost effective, and efficient implementation
- C. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
- D. Store equipment in spaces with environments that are controlled within the manufacturer's ambient storage temperature and humidity tolerances for non-operating equipment.
- E. The Integrator must furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable specifications, standards, and requirements before the system is considered for acceptance.

**C. Quality Control**

- (1) To meet all applicable requirements, the Integrator must supply documentation of all test results to the Engineer prior to approval of the system.
- (2) In lieu of or in addition to the above, the Engineer must accept outside Integrator and third party test results.
- (3) The Integrator must perform local field operational tests at each field location and a central system operational test at the TMC. The Integrator must develop an Acceptance Test Plan and perform acceptance testing in accordance with the plan and the test procedures detailed herein, within the plan set, and/or as directed by the Engineer. The Integrator must:
  - a. Verify that physical construction has been completed as detailed herein, within the plan set, and/or in the Contract;
  - b. Check power supply voltages and outputs;
  - c. Connect devices to the power sources;
  - d. Verify installation of specified cables and connections between servers and with the MITSC network.
  - e. Verify the operation of the servers to specified function, speed and capacity;
  - f. Interconnect the communication interface device into the communication network and verify connectivity to display location

**2. Documentation Required**

- A. Provide the necessary documentation as proof of qualifications of the Ethernet electronic equipment manufacturer.
- B. Provide the necessary documentation as proof of qualifications of the Integrator.
- C. Provide a complete detail cut-sheet on all equipment under this Special Provision.



- D. Highlight each individual item on cut-sheet.
- E. Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- F. Provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- G. Provide a shop drawing showing all devices and their connectivity.
- H. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

- (1) The Integrator must provide ten (10) paper copies and one electronic copy of all documentation materials to the Engineer.
- (2) The Integrator must format the electronic copy as a Microsoft Word text document or in Adobe Acrobat portable document format.
- (3) The Integrator must submit a sample documentation file for approval prior to commencing this task.
- (4) Documentation must include at a minimum:
  - a. Installation location information
  - b. Model/Serial number
  - c. Wiring diagram
  - d. Configuration file
  - e. Test results
  - f. Training materials
  - g. User's manual

### 3. Equipment

#### A. General

- (1) Throughout the project, the Integrator must retain workers with networking knowledge (i.e., protocols, network-addressing schemes) for equipment set-up. The personnel must have the ability and equipment to field verify equipment locations to ensure reliable communication links (e.g., fiber testing equipment).
- (2) Use shielded and grounded coaxial and twisted-pair cable for inter-shelf Ethernet Backbone of equipment.
- (3) Provide surge protector that protects the power conductor and control conductor (including return conductors).
- (4) Transient voltages, surges, and sags must not affect the equipment operations.
- (5) The equipment must meet all the requirements in Section 2.1.4 "Power Interruption" of the National Electrical Manufacturer's Association (NEMA) standard TS-1 for traffic control.
- (6) Refer to Special Provision for Grounding and Bonding for additional requirements.
- (7) The equipment must be designed such that the failure of it is to not cause the failure of any other unit of equipment.
- (8) Design modular equipment to allow major portions to be readily replaced in the field.
- (9) Design equipment for ease of maintenance. All equipment parts must be readily accessible for inspection and maintenance. Test points must be provided for checking essential voltages and waveforms.

- (10) PC Workstations and Server equipment is to be interoperable. Latest released software versions, patches, releases, license requirements, and related configuration options are all the responsibility of the Integrator.
- (11) Provide and install all available software upgrades through final acceptance.
- (12) Furnish and install data and video patch cords and jumpers as an appurtenance to the communications devices.
- (13) Furnish and install the required power adapter as an appurtenance to the communications device.
- (14) Furnish all operator and/or user's manual and any applicable firmware and software

#### H. Installation and Integration

- (1) Install each 10GigEBS meeting all specifications, standards and material requirements contained herein, power supply cord or adapter, all mounting hardware, Manufacturers Operation Manual, required testing results, manufacturers technical specification, and the cost of all materials, training, warranty, equipment, and all appurtenances necessary to the complete installation of the unit.
- (2) Perform all setup, programming, focusing adjustments, calibrations, and internal set-up procedures recommended by the equipment manufacturer. The Integrator must develop the configuration of the 10GigEBS to provide for full system performance as described in this specification, identified in the plans, or as directed by the Engineer. The Integrator must develop a configuration plan and submit the plan to the Engineer for approval before switch configuration may begin. The plan must identify the following minimum configuration parameters:
  - (a) IP Addressing;
  - (b) STP, RSTP setup;
  - (c) Port configuration;
  - (d) Routing setup;
  - (e) IP Multicast setup;
  - (f) Network topology;
  - (g) RPR configuration;
  - (h) VLAN;
  - (i) Prioritization; and
  - (j) QoS configuration.
- (3) Mark all patch cords, jumpers, and cables, regardless of length, with wrap-around number or letter cable markers at both ends. These labels must be self-laminating to ensure durability. Marking codes used on cables must correspond to codes shown on the drawings, and/or the written documentation of the "as-built" system the Integrator must supply.
- (4) The Integrator must securely install and mount the unit(s) as specified in the plans in the existing hub locations and at the MITSC. It is the Integrator's responsibility to ensure that the units submitted and supplied as part of this project are capable of being installed in all existing locations without adversely affecting the operations or maintenance of the Traffic Signal Cabinet and the unit(s) installed under this project. It is also the Integrator's responsibility to ensure adequate, redundant power meeting the manufacturer's recommendations is provided for each 10GigEBS installed. Some installations may require an additional 19" EIA Rack or relocation of existing equipment in order to provide adequate vertical rack space. It is the Integrator's responsibility to provide adequate rack space for each 10GigEBS installation. In all cases, the

Integrator must submit plan and material details to the Engineer for approval prior to ordering materials or proceeding with installation.

D. Installation and Integration

- (1) The Integrator must furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable specifications, standards, and requirements before the system is considered for acceptance. It is the Integrator's responsibility to ensure that all features, functions, and performance measures detailed herein, within the plan set, and/or in the Contract are provided.
- (2) All materials furnished, assembled, fabricated, or installed as detailed herein, within the plan set, and/or in the Contract must be new products obtained from the manufacturer or reseller. The Integrator must not use reconditioned equipment or system components. The materials, equipment, and components must be commercial off-the-shelf (COTS) products.
- (3) Cable runs of longer than 25 feet may be fabricated to length on site provided that all specification requirements other than COTS requirements are met. Splices are not allowed in any cables.
- (4) The Integrator must furnish all tools, equipment, materials, supplies, and manufactured hardware, and must perform all operations and equipment integration necessary to provide complete, fully operational equipment as specified herein, within the plan set, and/or in the Contract.
- (5) Furnish, install and integrate all available software upgrades through final acceptance.
- (6) Furnish, install, and test data and video patch cords, as well as the required power adapter as an appurtenance to the DVE/DVD.
- (7) Complete initial ITS tests prior to implementation to ensure the specified operation.
- (8) CCTV Integration
  - (a) Integrate the new CCTV cameras into the communications network and establish operational control of the devices with the communications network.
  - (b) Test the CCTV networked equipment to verify functionality on the network.
- (9) Vehicle Detector Integration
  - (a) Integrate the Vehicle Detectors into the communications network and establish operational control of the Vehicle Detector Controller with the Backbone Communications Network.
  - (b) Test the Vehicle Detector networked equipment to verify functionality on the network.
- (10) Software
  - (a) Configure applicable (CCTV, MVDs) management software on applicable server(s) and on MITSC workstations to recognize the entire field installed devices in the area of work.
  - (b) After all software is configured, the Integrator is to test each application to verify all present ITS functionality is available from the MITSC to operate, control, troubleshoot, and otherwise maintain all devices installed in the field.

C. Power Requirements

- (1) The equipment must meet all of its specified requirements when the input power is 120/240 volts (plus or minus 20 VAC), 60 Hz (plus or minus 3 Hz). The equipment is to be powered from the output of the uninterruptible power supply (UPS).

D. Testing

- (1) Backbone Communications Network equipment must be tested per the Project Acceptance Test Plan and the manufacturer's testing/operational specifications.
  - (2) Communications testing between all connected devices must be provided as indicated on drawings. Testing must include connectivity, bandwidth, load and fault recovery of connected devices.
  - (3) At each device included in the work of this project, the Integrator must test and demonstrate all features of control and operation from the MITSC. This is to include functioning of the CCTV Cameras, MVDS, as well as demonstrating full diagnostic capability of the Ethernet network (both fiber-based and wireless).
4. Warranty
- Terminal Server/s. 10 GigEBS/s, DVE/s, DVD/s, and Communications Management Chassis (Rack/s) provided for the Backbone Communications Network will carry a manufacturer's standard warranty (parts, software and labor) of 5 years from the date of final acceptance. Server/s provided for the Backbone Communications Network will carry a manufacturer's standard warranty (parts, software and labor) of 1 year from the date of final acceptance.

**d. Measurement and Payment.** The completed work will be paid for at the contract unit price for the following contract item (pay item):

<b>Contract Item (Pay Item)</b>	<b>Pay Unit</b>
Backbone Communications Network .....	Lump Sum

The work for constructing the **Backbone Communications Network** includes all labor, equipment, and materials to construct the item.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**BLUE WATER BRIDGE OPERATIONS CENTER MODIFICATIONS**

DES: MM

1 of 29

03-15-2006

**a. Description.** This work consists of modifying the existing Blue Water Bridge Operations Center (BWBOC). The BWBOC is located at 1410 Elmwood, Port Huron, MI 48060. This work must be done in accordance with the Michigan Department of Transportation 2003 Standard Specifications for Construction, except as modified. No additional items or payment other than what is indicated herein is required in this estimate of work. Items and work covered under this special provision include the following:

- A. 1Gig Ethernet Backbone Switch (1GigEBS)
- B. ITS System Server
- C. Digital Video Encoder MPEG4 (DVE)
- D. Digital Video Decoder MPEG4 (DVD)
- E. Digital Video Encoder/Decoder Rack Chassis
- F. Digital Video Encoder/Decoder Rack Chassis Redundant Power Supply
- G. Uninterruptible Power Supply (UPS)
- H. Communications and Server Racks
- I. Demolition BWB OPS RM
- J. Re-construction BWB
- K. Miscellaneous Communications Wiring
- L. Power Service Upgrade If Required
- M. Jumpers and Patch Cords
- N. Remote System Mock-up and Demonstration
- O. Full System Burn-In
- P. System Integration of Ops-RM Equipment and Server Aggregation
- Q. 67-Inch DLP Video Display
- R. Operator Console with (2) Flat Screen Monitors, (1) Operator's Chair
- S. 16-Input Color Video Multiplexer
- T. ITS Work Station

1. General

The INTEGRATOR must furnish, install, integrate and test all equipment and components necessary to provide an updated Operations Room, control room and system as specified herein, with full and complete ITS functionality in all respects, without additional expense to the Department.

2. Qualifications

- A. The proposed manufacturer of the Ethernet communications equipment contained within this Special Provision is required to demonstrate a minimum of five years experience in the Ethernet switch industry and recognized as an approved source of Ethernet switches by MDOT.
- B. The proposed installer/integrator of this Blue Water Bridge Operations Room and ITS System is required to demonstrate a minimum of three years project experience in the installation, integration, configuration, and setting up of Ethernet networks of

similar size. The proposed installer/integrator is required to submit a list of project references including client project manager and contact information.

3. Summary

- A. The payment process including partial payment will be governed by Section 109 of the *Michigan Department of Transportation Construction Manual*.
- B. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the INTEGRATOR as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- C. The INTEGRATOR must furnish and install complete with all accessories the required communications pathways.

4. Requirements of Regulatory Agencies

The compliance with the latest edition of the following codes or standards is required:

- A. *International Building Code (IBC)*.
- B. *National Television Systems Committee (NTSC)*.
- C. *Moving Picture Experts Group (MPEG)*.
- D. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*.
- E. *National Electrical Manufacturers Association (NEMA)*.
- F. *National Fire Protection Association (NFPA) 70 - National Electrical Code*.
- G. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code*.
- H. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177*.
- I. *Underwriters' Laboratories Standards 96 and 96A (UL)*.
- J. *Underwriters' Laboratories Standards 6500-C (UL)*.
- K. *American National Standards Institute Standard C2 (ANSI)*.

5. General Requirements

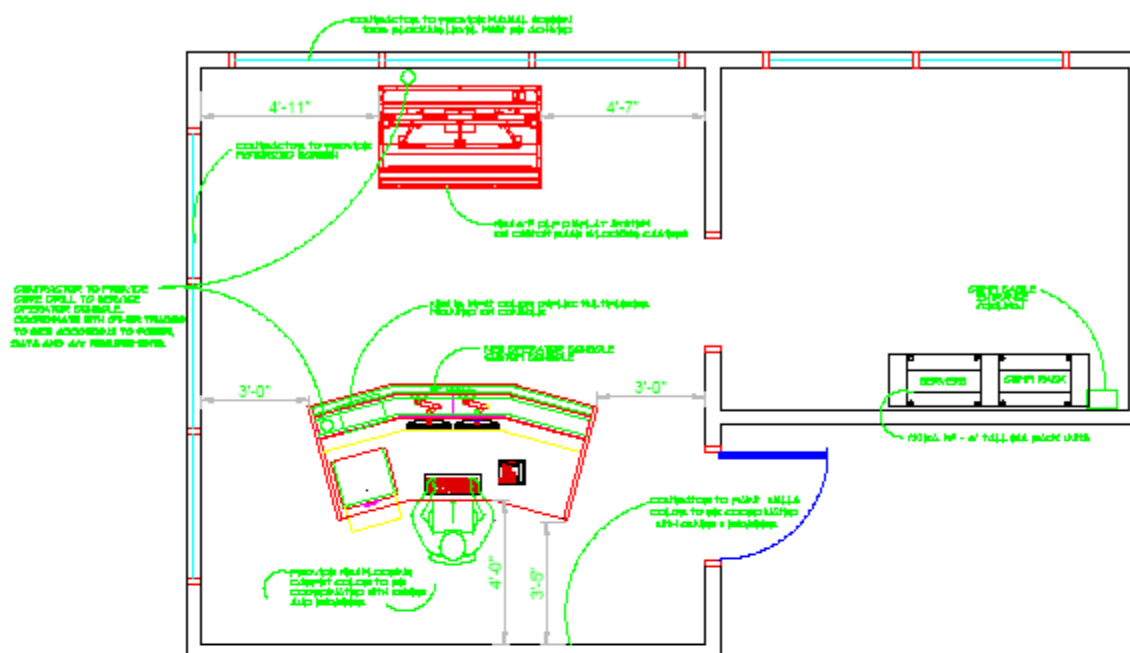
- A. Furnish, assemble, fabricate or install all new materials in accordance with the details shown on the Plans and in the Specifications.
- B. Furnish and install all conduits, pull boxes, cabling and connections necessary to provide a fully functional OPERATIONS ROOM.
- C. Use identical and completely interchangeable Digital Video Encoders (DVE) and Digital Video Decoders (DVD) as specified and utilized for all segments (BCN, MITSC, etc.) of this project.
- D. Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- E. Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the INTEGRATOR.
- F. All equipment required for the configuration and testing of devices and subsystems contained within this project must be supplied by the INTEGRATOR as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

6. Functional Specifications

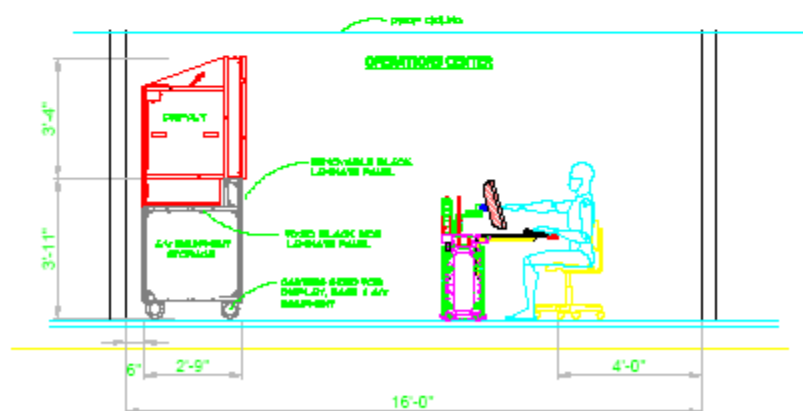
- A. This Special Provision governs the minimum acceptable equipment and installation requirements for one 67" (diagonal) DLP Display and appurtenances necessary to provide a viewable image from the location of the single operator console.
- B. This Special Provision governs the minimum acceptable equipment and installation requirements for a Single Station Operator Console and appurtenances necessary to house the ITS System Workstation, ITS System Server, Gigabit Ethernet Switch, Video Quad Appliance, UPS, six (6) Digital Video Decoders, four (4) Digital Video Encoders and their appurtenances as identified within this special provision.

Figures 1 through 4 (BWB Ops Room Renovation Details)

Figure 1 (Plan View #1 BWB Operations Room)



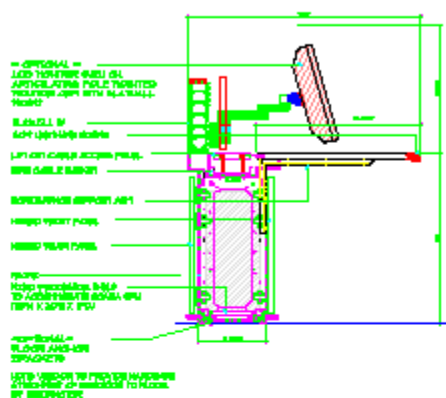
## DISPLAY SYSTEM DESIGN PLAN VIEW



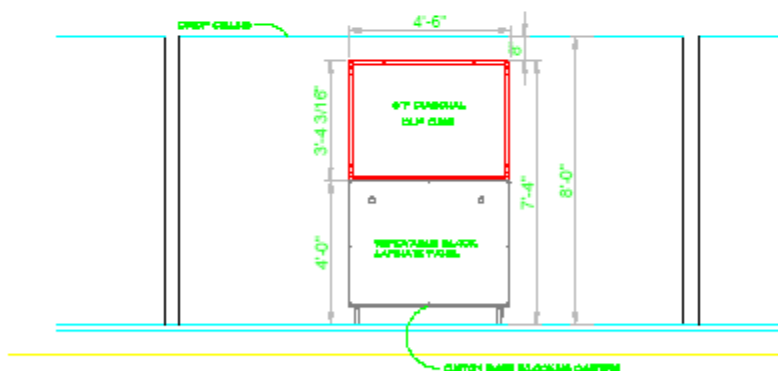
### DISPLAY SYSTEM DESIGN SIDE ELEVATION



Figure 2 (Plan View #2 BWB Operations Room)

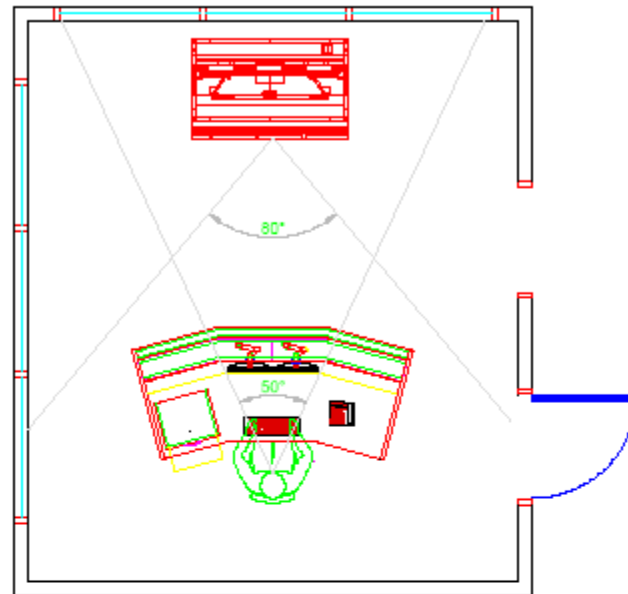


### CONSOLE SECTION VIEW

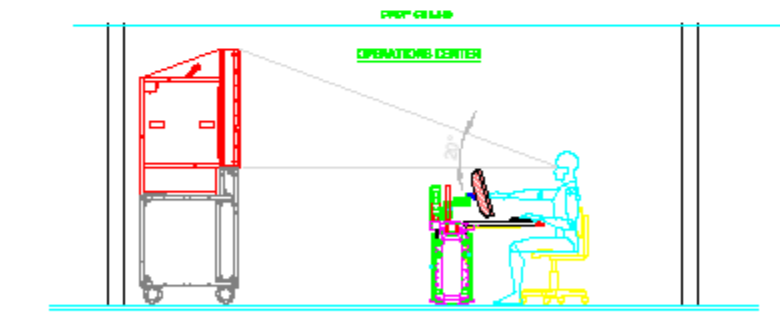


### DISPLAY SYSTEM DESIGN FRONT ELEVATION

Figure 3 (Sight Line Diagram No. 1)

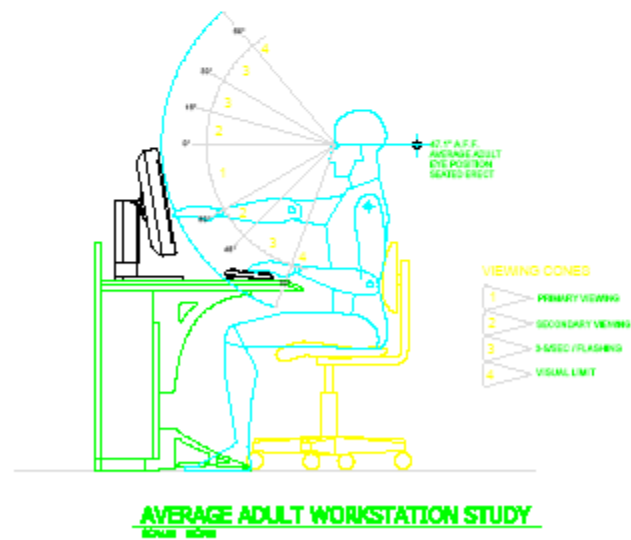
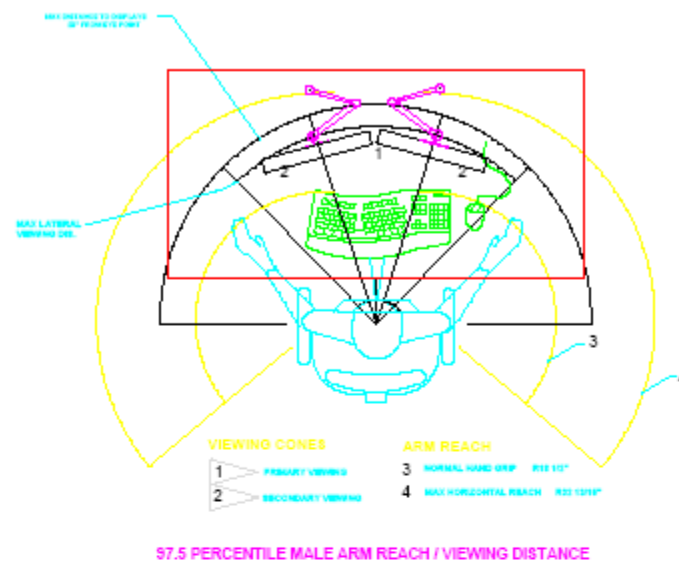


**HORIZONTAL SIGHT LINE ANALYSIS**  
SCALE 1/8"=1'-0"



**VERTICAL SIGHT LINE ANALYSIS**  
SCALE 1/8"=1'-0"

Figure 4 (Operator Ergonomics)



## b. Materials.

1. 67" Diagonal DLP Display
  - A. Provide a high-definition DLP display that is compatible with the following sources:
    - (1) VGA PC signals via mini D-SUB 15 Pin;
    - (2) Composite video (BNC);
    - (3) S Video via mini DIN 4PIN (75-ohm);
    - (4) Component Video (RGB); and
    - (5) Digital Video Interface (DVI-D).
  - B. Include a custom front access display housing/base with locking casters, such that the housing/base fully supports the DLP display, Video Display and CCTV Streaming Video Switch and all other appurtenances related to the DLP display.
  - C. Minimum 4 ft. sill height.
  - D. Include a standard EIA 19" equipment rack in each bay of the housing/base.
  - E. Include a removable black laminate front panel for access to electronic equipment.
  - C. Display
    - (1) 1000:1 contrast ratio, nominal
    - (2) 1200:1 contrast ratio, maximum.
    - (3) 1024 x 768 resolution.
    - (4) 16.8 Million colors;
    - (5) 100/120W UHP lamp
    - (6) Minimum 10,000 hours lamp life;
    - (7) Double-speed, 4-segment color wheel;
    - (8) 180 degree viewing angle (horizontal and vertical)
    - (9) Two element Fresnel/Lenticular screen type with low reflective finish
    - (10) Maximum 1mm mullion
    - (11) One (1) Serial DB-9 for management
    - (12) Include a remote control.
    - (13) Include a 6-inch LCD touch screen and media controller
    - (14) Remote monitoring/control via EIA-232.
    - (15) Operating Temperature: 50°F - 95°F (10°C - 35°C).
    - (16) Operating Humidity: 25% - 65%, non-condensing.
    - (17) Power Input: 100-240 VAC +/- 10% (autoswitching), 50/60 Hz nominal.
    - (18) Power Consumption: 250 watts maximum.
    - (19) Thermal dissipation: 850 BTU/hr maximum.
2. 16-Input Color Video Multiplexer
  - A. Provide a graphic and video switch/wall controller to selectively manage the DLP wall and provide the following:
    - (1) Provide full duplex operation.
    - (2) Provide an enhanced PCI backplane capable of dynamically allocating bandwidth.
    - (3) House a minimum of four (4) PCI based input cards, 4 inputs per card.
    - (4) Contain a minimum of 8 analog (NTSC) inputs.
    - (5) Simultaneously decode a minimum of 8 MPEG-4 digital video streams.
    - (6) Support output resolutions up to UXGA (analog) and SXGA (digital).
    - (7) Support up to 80 channels in native windows environments and unlimited channels for X-Windows environments.
    - (8) Freely moveable and scaleable display windows.
    - (9) Provide open APIs to allow cross vendor software integration and support.
    - (10) Accept triggered commands from third party software allowing re-configuration of the display based on the received command.

- (11) Provide a software control suite allowing the end-user to choose which services are required for use in the control room.
  - (12) The control suite includes at a minimum:
    - a. Display wall configuration/manipulation
    - b. Preset triggers
    - c. Remote pointer/keyboard
    - d. Screen Scraping capabilities
3. Single Station Operator Console
- A. The following specifications govern the design, fabrication and installation of a modular console for a flat panel display workstation based environment. The specification must define the manner in which console and related accessory items must be constructed.
  - B. The console must accommodate a variety of computer, communication, display and operator interface devices. They must also include efficient ventilation and integral cable management systems. The design of the console must address the functional, ergonomic and aesthetic requirements of the particular working environment while complying with accepted human factor and ergonomic standards for viewing distance, angle, work surface height and knee well space.
  - C. The console must be of modular design, facilitating future equipment retro-fits and reconfigurations without requiring any major modifications to the structure or exterior elements. The console must be manufactured to industry recognized quality standards. The console must use modern exterior finish materials to achieve a distinguished appearance while maintaining durability and functionality required for a 24/7 operating environment.
  - D. Ergonomically correct seating must be provided for the operator. The seating must have the following characteristics:
 

Cushions:

    - (a) Rated for twelve hours continuous use;
    - (b) Molded polyurethane foam;
    - (c) Armrests and optional seats to have top layer of techno gel; and
    - (d) Upholstered with a variety of materials customized for the unique form of the cushion.

Cushion Pans:

    - Injection molded, integral color plastics;
    - Handles & Levers; and
    - Injection molded, reinforced, integral color nylon and die cast aluminum with fused powder coating.

Stored Energy Devices:

    - Nitrogen gas charged cylinder for infinitely adjustable seat height;
    - Coil spring in the self adjusting recline mechanism; and
    - Elastomer spring in the dual backrest.

External Frame and Five-arm Base:

    - Die cast aluminum with fused plastic coating or polished aluminum finish;
    - Foot Ring; and
    - Die cast aluminum spider with chrome plated steel ring.
  - E. Console Specifications
    - (1) Dimensions

**Table 1: Dimensions**

Height of work surface	28.5 inches
Maximum Height of upper edge of console	45 inches
Maximum overall console depth	51 inches
Work surface depth	19.5 inches

## (2) Structural

- (a) A console must be comprised of an internal, Computer Numeric Controlled (CNC) fabricated structural 12-gauge cold rolled steel frame to form an open architecture within the console and to support equipment, exterior architectural exterior panels, work surfaces and recessed flat screen monitor shelves.
- (b) CNC techniques are employed to punch out and form parts to ensure that they are manufactured within a tolerance of  $\pm 0.001$  inches over 4 feet. Manufactured angle tolerances must be within  $\pm 0.2$  degrees.
- (c) The structural metal frame includes vertical steel frame members connected at regular intervals by horizontal steel stringers that span the perimeter of the frame structure.
- (d) The frame member design allows for cable routing to be integrated into the frame.
- (e) All frame components must be finished with electrostatic powder coating.
- (f) Vertical steel frames and horizontal members form a rigid structural frame and are assembled with standard mechanical fasteners that facilitate knockdown for shipping, field reassembly and future reconfiguration.
- (g) The steel frame supports all panels and equipment mounts, permitting the selection of decorative design features that are not structural.

## (3) Monitor Shelf

- (a) The recessed monitor shelf positions LCD monitors below the height of the working surface for an improved ergonomic viewing angle by a seated operator without obscuring visibility of the screen.
- (b) The shelf must be recessed 4 inches below standard work surface height.
- (c) The shelf must be constructed of 1-inch particle-board core with high-pressure laminate finish.
- (d) The rear edge must be finished with half-round black plastic extrusion.
- (e) The surface must be smooth and free of any protrusions, except for low-profile cable grommets and valance supports.
- (f) Cable grommets must be low profile, rectangular cable grommets with removable cover.
- (g) The front edge of the recessed monitor shelf must be fitted with a flexible polyurethane strip that covers the gap between the recessed monitor shelf and work surface. The apron must act as a continuous cable grommet for keyboard and mouse cables.

## (4) Task Lighting

- (a) The task lighting system must be integrated into the console so that the light falls on the work surface only, and not into the operator's eyes or create glare on the flat screen monitor.
- (b) The task lighting system must be low profile, dimmable xenon and doesn't flicker or create hotspots or pools of light on the work surface.

## (5) Work Surface

- (a) The work surface depth must be 19.5 inches.
- (b) The fixed-height work surface height must be 28.5 inches.

- (c) Work surfaces must be designed to provide the fewest joints possible, assembled with draw bolts and splines to provide flush, tight work surface joints.
  - (d) The work surface must be constructed of one-inch particleboard core finished with high pressure plastic laminate.
  - (e) The work surface must be supported by a CNC punched and formed, 12-gauge steel cantilever system. The work surface must be designed to withstand 200-pounds per square foot load.
  - (f) The height-adjustable work surface section must be powered by an electromechanical actuator, with a stroke length of 22-inches. In addition, an optional manual actuator with a 13-inch stroke length must be provided.
  - (g) A continuous flexible plastic grommet lip allows unlimited positioning of keyboard and mouse cables with no holes cut into the work surface for rectangular grommet placement.
  - (h) The work surface incorporates a durable rounded, molded rubber front edge carried on an extruded aluminum carrier for concealed attachment to the work surface for operator comfort.
- (6) Side Panels and Doors
- (a) Exterior (front and rear) panels must be constructed of 11/16-inch particleboard core finished with plastic laminate.
  - (b) Front doors must be pressed curved with a radius to match overall console footprint. Rear panels are pressed flat.
  - (c) Doors must fastened with adjustable, quick release hinges.
  - (d) Panels must be supported from the console frame with hanging clips. Gables must be fastened with threaded inserts and bolts.
- (7) Equipment Mounts
- (a) Equipment trays must be fabricated with 16-gauge perforated metal to facilitate airflow to equipment and to support equipment loads.
  - (b) Equipment trays are mounted on extra-duty steel bearing full extension slides. As an option equipment trays may be positioned on shelf pins installed in metal vertical support bars for height adjustability.
  - (c) Non-rack mounted equipment must be installed on trays.
  - (d) Access to equipment must be through removable front or rear panels.
  - (e) CPU Rack:
    - (i) EIA standard 19-inch rack mount rails bolted to the console frame.
    - (ii) Provide enough rack space to mount the ITS System Server and the ITS Workstation.
- (8) Electrical
- Console frame design must allow for internal cable routing and the console incorporate electrical duplex outlets mounted internally to the structural steel frame and externally in the architectural panels as appropriate, in sufficient numbers to accommodate all mounted equipment, task lighting and ventilation fans.
3. ITS System Server (ISS)
- A. Summary
- (1) The ISS contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment.
  - (2) The ISS must be furnished, installed, integrated and tested to accomplish the functional and performance requirements contained within this special provision.
- B. Functional and Performance Requirements

- (1) The materials used and workmanship completed by the INTEGRATOR must be in accordance with the most recently accepted and approved industry standards. All materials, equipment, supplies, installations, and testing must comply with the project requirements, the latest editions of the following standards, as applicable, and any other applicable standards and requirements:
  - (a) International Organization for Standardization;
  - (b) American Society of Testing and Materials (ASTM);
  - (c) Institute of Electrical and Electronic Engineers (IEEE);
  - (d) American National Standards Institute (ANSI);
  - (e) National Electrical Manufacturers' Association (NEMA);
  - (f) Underwriters' Laboratories, Inc. (UL);
  - (g) National Board of Fire Underwriters;
  - (h) Electrical Testing Laboratories (ETL);
  - (i) Telcordia (formerly Bellcore) technical advisories and requirements;
  - (j) Electronic Industries Association (EIA);
  - (k) National Electrical Code (NEC);
  - (l) American Standard Code for Information Interchange (ASCII);
  - (m) International Telecommunications Union (ITU);
  - (n) Telecommunications Industries Association (TIA);
- (2) The ISS must operate commercial off-the-shelf (COTS) software. The server must be designed for 24/7 operation. The INTEGRATOR must furnish and install one ISS in the BWBOC. All installation must be coordinated with the Engineer and with the BWBOC IT/IS Manager.
- (3) The ISS must execute the Microsoft Windows Server 2000 operating system with the capability to migrate to Windows Server 2003.
- (4) The ISS must execute the 360 Surveillance Cameleon ITS, Advanced ITS Software. Provide a minimum of 25 User Licenses. The software must support simultaneous NTCIP and non-NTCIP control of the CCTV cameras, existing and proposed. The software must support NTCIP DMS control of the proposed Dynamic Message Signs. The software must manage the join and leave commands of IP Video Multicasting.
- (5) Provide, as an appurtenance to the ISS, client software required to provide video switching, viewing and control at all existing control room workstations. The client software must also allow any user at any workstation to display any selected video stream (both existing and proposed) to any selected video monitor or output.
- (6) The ISS must use one Intel Xeon 3.6 Gigahertz processor with an 800 Megahertz Front Side Bus and at least 1 Megabyte of level 2 cache. The server must include at least 1 Gigabyte of Dynamic Random Access Memory operating at 400 Megahertz or greater with an additional at least 1 Gigabyte expansion kit on two 512 Megabyte DIMMs.
- (7) Storage devices must be factory-installed within the server housing and must include read-only compact disk (CD-ROM) and hard disk devices. The hard disks must be 3 or more 10,000 RPM hard drives connected through SCSI to a Hewlett-Packard Smart Array 6i or equivalent hard drive controller. Each hard drive will have a capacity of 72.8 Gigabytes or greater. The CD-ROM drive must be 24X or faster.
- (8) The ISS must include networking and interface ports for both operational and maintenance use. Networking must be provided by dual self-detecting 10/100/1000 RJ-45 ports operating standards-compliant Ethernet. Each server must have one (1) standard 9-pin RS-232 serial port configurable between a



minimum of at most 1200 bits per second and a maximum of at least 115,000 bits per second. Each server must provide one point-device (mouse) interface, one monitor interface (RGB 15-pin of at least VGA resolution), one (1) standard 6-pin keyboard interface, and at least 2 USB 2.0 ports. Two of the servers must be installed at the OPERATIONS ROOM and must include 56K data modems. The modems must be internal on PCI 2.2 cards that can be accommodated by the server housing with V.90 or later compatibility and MNP10 or better error correction. Each modem card must be capable of connecting to at least one standard RJ-11 analog telephone line using the AT command set.

- (9) The ISS must be rack-mountable in a standard 19-inch equipment rack requiring no more than 2U of rack space and weigh no more than 70 lbs. The server housing must accept a minimum of three (3) full size PCI-X cards. The equipment must operate on and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC or less and a maximum operating input of 132 VAC or greater. The maximum power consumption must be 575 Watts for each server. Each server must have hot pluggable redundant power supplies (both NEMA and IEC cords) and hot pluggable redundant ventilation fans.
  - (10) Install the ISS in rack space provided in the operator console.
  - (11) Provide a two port desktop keyboard, video, and mouse (KVM) switch able to switch between the ISS and Workstation contained within this special provision.
  - (12) Except as stated otherwise herein, within the plan set, and/or in the Contract, the servers must meet all specifications during and after being subjected to an ambient operating temperature range of 10° to 35° Celsius (C) at sea level and a non-condensing relative humidity of 10% to 90%. The acceptable ranges for shipment and storage are -40° - 70° C and 5% - 95% relative humidity. The design must be inherently temperature compensated to prevent abnormal operation. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.
4. ITS Workstation
- A. Summary
    - (1) The ITS Workstation contains the necessary hardware and software to provide IP video switching capability to client workstations in an Ethernet/IP network environment.
    - (2) The ITS Workstation must be furnished, installed, integrated and tested to accomplish the functional and performance requirements contained within this special provision.
  - B. Qualifications
    - (1) The manufacturer must demonstrate that it has been in the business of providing such product for at least five years.
    - (2) The installer must have been in the business of installing, setting up and maintaining Ethernet network systems for at least three years. In addition, the installer must be certified by the manufacturer of the switches as competent to install, set up and maintain those products. The certification requirements will be waived only if the installation is supervised and approved by an on-site representative of the manufacturer.
  - C. Functional and Performance Requirements
    - (1) The materials used and workmanship completed by the INTEGRATOR must be in accordance with the most recently accepted and approved industry standards. All materials, equipment, supplies, installations, and testing must comply with the

project requirements, the latest editions of the following standards, as applicable, and any other applicable standards and requirements:

- (a) International Organization for Standardization;
  - (b) American Society of Testing and Materials (ASTM);
  - (c) Institute of Electrical and Electronic Engineers (IEEE);
  - (d) American National Standards Institute (ANSI);
  - (e) National Electrical Manufacturers' Association (NEMA);
  - (f) Underwriters' Laboratories, Inc. (UL);
  - (g) National Board of Fire Underwriters;
  - (h) Electrical Testing Laboratories (ETL);
  - (i) Telcordia (formerly Bellcore) technical advisories and requirements;
  - (j) Electronic Industries Association (EIA);
  - (k) National Electrical Code (NEC);
  - (l) American Standard Code for Information Interchange (ASCII);
  - (m) International Telecommunications Union (ITU);
  - (n) Telecommunications Industries Association (TIA);
- (2) The ITS Workstation must operate commercial off-the-shelf (COTS) software. The workstation must be designed for 24/7 operation. The INTEGRATOR must furnish and install one ITS Workstation in the BWBOC. All installation must be coordinated with the Engineer and with the BWBOC IT/IS Manager.
  - (3) The ITS Workstation must execute the Microsoft Windows XP Professional, Service Pack 2 operating system.
  - (4) The ITS Workstation must execute the 360 Surveillance Cameleon ITS, Advanced ITS Software Client. Provide 10 User License for use by MDOT Metro Region. The software must support simultaneous NTCIP and non-NTCIP control of the CCTV cameras, existing and proposed. The software must support NTCIP DMS control of the proposed Dynamic Message Signs. The software must manage the join and leave commands of IP Video Multicasting.
  - (5) Provide, as an appurtenance to the ITS Workstation, all other client software required to provide video switching, viewing and control at this workstation. The client software must also allow the user to display any selected video stream (both existing and proposed) to the DLP display (2 inputs), or to one or both 17" LCD monitors.
  - (6) The ITS Workstation must use one Intel Xeon 3.6 Gigahertz processor with an 800 Megahertz Front Side Bus and at least 1 Megabyte of level 2 cache. The workstation must include at least 1 Gigabyte of Dynamic Random Access Memory operating at 400 Megahertz or greater with an additional at least 1 Gigabyte expansion kit on two 512 Megabyte DIMMs.
  - (7) Storage devices must be factory-installed within the workstation housing and must include read-only compact disk (CD-ROM) and hard disk devices. The hard disk must be one (1) 7200 RPM hard drive connected through SATA to a on board motherboard hard drive controller. The hard drive will have a capacity of 72.8 Gigabytes or greater. The CD-ROM drive must be 24X or faster.
  - (8) The ITS Workstation must include networking and interface ports for both operational and maintenance use. Networking must be provided by dual self-detecting 10/100/1000 RJ-45 ports operating standards-compliant Ethernet. Each workstation must have one (1) standard 9-pin RS-232 serial port configurable between a minimum of at most 1200 bits per second and a maximum of at least 115,000 bits per second. Each workstation must provide one point-device (mouse) interface, one monitor interface (RGB 15-pin of at least VGA resolution), one (1) standard 6-pin keyboard interface, and at least 2 USB

2.0 ports. Two of the workstations must be installed at the OPERATIONS ROOM and must include 56K data modems. The modems must be internal on PCI 2.2 cards that can be accommodated by the workstation housing with V.90 or later compatibility and MNP10 or better error correction. Each modem card must be capable of connecting to at least one standard RJ-11 analog telephone line using the AT command set.

- (9) The ITS Workstation must be rack-mountable in a standard 19-inch equipment rack requiring no more than 2U of rack space and weigh no more than 70 lbs. The workstation housing must accept a minimum of three (3) full size PCI-X cards. The equipment must operate on and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC or less and a maximum operating input of 132 VAC or greater. The maximum power consumption must be 575 Watts for each workstation. Each workstation must have hot pluggable redundant power supplies (both NEMA and IEC cords) and hot pluggable redundant ventilation fans.
- (10) Install the ITS Workstation in rack space in operator console.
- (11) Provide a two port desktop keyboard, video, and mouse (KVM) switch able to switch between the ITS Workstation and Workstation contained within this special provision.
- (12) Except as stated otherwise herein, within the plan set, and/or in the Contract, the workstations must meet all specifications during and after being subjected to an ambient operating temperature range of 10° to 35° Celsius (C) at sea level and a non-condensing relative humidity of 10% to 90%. The acceptable ranges for shipment and storage are -40° - 70° C and 5% - 95% relative humidity. The design must be inherently temperature compensated to prevent abnormal operation. The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.

## 5. Gigabit Ethernet Switch

### A. Summary

- (1) Provide a Gigabit Ethernet (GigE) switch located in the BWBOC and connected by way of CAT 5e copper cabling to the Wireless Link Backhaul Radio installed on the roof of the BWBOC as part of a separate pay item. This section describes the furnishing, installation, integration and testing of the GigE switch.
- (2) The GigE switch's role must provide an Ethernet network connection from the field communications network to the BWBOC. Further, the GigE switch also must be furnished and integrated in such a way as to provide switched 10/100/1000 Mbps connection over copper medium for links to the operator console and network devices located at the BWBOC.

### C. Functional Requirements

- (1) Provide the GigE switch in a rack-mountable installation configuration and meet the specified requirements for a controlled office/equipment room temperature environment.
- (2) Provide a GigE switch with highly reliable, non-blocking, switched Ethernet data communications via Category 5e copper transmission medium at full wire speed.
- (3) Provide a GigE switch that is Certified NEBS Level 3 compliant.
- (4) Provide a display with the following diagnostic LED's for each port:
  - (a) LINK;
  - (b) TX;

- (c) RX;
- (d) SPEED; and
- (e) DUPLEXITY.

D. Technical Requirements

(1) Compliant with the following networking standards:

- (a) IEEE 802.3 – 10BASE-T (Ethernet);
- (b) IEEE 802.3u – 100BASE-TX (Fast Ethernet);
- (c) IEEE 802.3x – Full Duplex and Flow Control;
- (d) IEEE 802.3z – Gigabit Ethernet;
- (e) IEEE 802.3ae – 10 Gigabit Ethernet;
- (f) IEEE 802.1D – MAC Bridges (Spanning Tree Protocol);
- (g) IEEE 802.1w – MAC Bridges (Amendment 2, Rapid Spanning Tree);
- (h) IEEE 802.1 Q – Virtual Bridged LAN (Port-Based VLAN);
- (i) IEEE 802.1ad – Link Aggregation;
- (j) IEEE 802.1p – Priority Queuing;
- (k) IEEE 802.17 – Resilient Packet Ring;
- (l) RFC 2236 IGMP v.2;
- (m) RFC 2475 DiffServ;
- (n) RFC 768 UDP;
- (o) RFC 791 IP;
- (p) RFC 792 ICMP;
- (q) RFC 793 TCP;
- (r) RFC 783 TFTP;
- (s) RFC 826 ARP;
- (t) RFC 854 Telnet;
- (u) RFC 1157 SNMP v.1 and v.2;
- (v) RFC 1213 MIB II;
- (w) RFC 1493 Bridge MIB;
- (x) RFC 1643 Ethernet MIB; and
- (y) RMON 4.

(2) Provide GigE switch that is stackable in design (fixed port). The chassis must be capable of supporting multiple Ethernet interface modules.

(3) Minimum 4 Gbps non-blocking backplane/switch fabric.

(4) EIA/TIA 19" rack mountable.

(5) Provide, at a minimum, the following Ethernet and management ports.

(a) Copper port requirements:

- (i) Twenty-four (24) copper ports.
- (ii) Type RJ45.
- (iii) Auto-negotiate for speed (10/100/1000) and duplexity (Full or Half) for each port.

(b) Management Port

- (i) Type RJ45, RJ11, or DB-9.
- (ii) Management cable must be provided by the manufacturer.

(6) Support Full Layer 2 and Layer 3 Management/Routing features. These include, but are not limited to:

- (a) IEEE 802.1D – MAC Bridges;
  - (i) Spanning Tree Protocol.
  - (ii) Meet or exceed the STP Healing rate that is published by the IEEE 802.1D Standard.
- (b) IEEE 802.1w – MAC Bridges, Amendment 2;
  - (i) Rapid Spanning Tree Protocol.

- (ii) Meet or exceed the RSTP Healing that is published by the IEEE 802.1w Standard.
- (c) IEEE 802.1Q – Virtual Bridged LAN;
  - (i) Port Based VLAN.
  - (ii) Meet or exceed that published by the IEEE 802.1Q Standard.
  - (iii) Minimum 4K VLAN address table required.
- (d) Forwarding/Filtering Rate;
  - (i) 14,880 pps (packets per second) for 10Mbps.
  - (ii) 148,800 pps for 100 Mbps.
  - (iii) 1,488,000 pps for 1 Gbps.
- (e) MAC Address Table;  
Minimum 4K MAC address table.
- (f) UDP
  - (i) Must support User Datagram Protocol.
  - (ii) RFC 768.
- (g) TCP/IP
  - (i) Must support Transmission Control Protocol/Internet Protocol v.4 or higher.
  - (ii) RFC 791 and RFC 793.
- (h) IGMP Support;
  - (i) Must support Internet Group Management Protocol v. 2 or higher.
  - (ii) RFC 2236.
- (i) SNMP Support;  
Must support SNMP v.1 and v.2 management.
- (j) Access via resident RS-232 management port; and
  - (i) Access via telnet or ftp.
  - (ii) RFC 1157, RFC 854, RFC 783.
- (k) RMON/SMON Support;
  - (i) Must support RMON for Ethernet Agent v.4.
  - (ii) Must have the capability to upgrade to SMON if required.
- (l) FTP Support;
  - (i) Must support File Transfer Protocol.
  - (ii) RFC 783.
- (m) NTP/SNTP Support.
  - (i) Must support Network Time Protocol/Simple Network Time Protocol.
  - (ii) NTP/SNTP Support.
- (n) QoS Support
  - (i) Must support Quality of Service configurations.
  - (ii) Must use or be compatible with DiffServ Protocol.
  - (iii) RFC 2475.
- (o) MPLS Support
  - (i) Must support Multi Protocol Label Switching traffic engineering.
  - (ii) RFC 2702.
  - (iii) Framework for IP Multicast in MPLS.
  - (iv) RFC 3353.
- (p) OSPF Support
  - (i) Must support Open Shortest Path First protocol.
  - (ii) RFC 2328.
- (q) PIM Support
  - (i) Must support Protocol Independent Multicasting.
  - (ii) Sparse Mode (PIM-SM).

- (iii) Version 2 or most recent
  - (iv) RFC 2362.
- (7) The GigE switch must contain ample memory (volatile and non-volatile) for storage of tables and data including, but not limited to:
  - (a) MAC Address.
  - (b) Boot Program.
  - (c) OS Program.
  - (d) Management Program.
  - (e) Logs.
- (8) Boot, OS and Management programs must be upgradeable and backwards compatible with older versions. The user must be able to perform upgrades via console, telnet or ftp.
- E. Error/Failure Requirements
  - (1) Log in every Error or Failure in an error log.
  - (2) The error log must be downloaded, saved or exported to basic text format.
  - (3) Manufacturer must have tested and certified by Bellcore/Telcordia Standard a Mean Time Between Failure (MTBF) of minimum 10 years.
  - (4) All materials and appurtenances must meet the specified requirements for controlled office/equipment room temperature environment. Specifically, operating temperature range must be between 0°C and +40°C and humidity must be between 0% and 85% (Non-Condensing).
- F. Cable Requirements
  - (1) Provide all power, data, and video cables for the display cubes, and controller, including a cable linking the controller to each of the inputs shown in the Plans.
  - (2) Twenty-four (24) Category 5e Ethernet patch cords for each GigE switch;
    - (a) Made to length (not to exceed 150 feet).
    - (b) Pinned straight through.
    - (c) 24 gauge, 4-pair conductor.
    - (d) RJ-45 snag-less connectors.
    - (e) Certified for 350 MHz operation.
    - (f) Blue in color.
  - (3) One (1) management cable for each switch;
    - (a) DB-9 Male to correct type of port described in.
    - (b) One (1) meter in length.
- G. Field Quality Control

Develop a detailed test plan for the GigE switch and revise it until it meets the Owner's approval. The plan must include:

- (1) Visual inspection of wiring.
- (2) Execution of all diagnostic routines provided by the manufacturer.
- (3) Execution of a graduated testing process. The process must begin from the field side and work up each level of the communications system. Each link must be tested in accordance with RFC 2544, RFC 3393 and RFC 1242. Tests must measure at a minimum:
  - (a) Back-to-back Packet Testing;
  - (b) Throughput;
  - (c) Burstability;
  - (d) Latency ;
  - (e) Frame Loss; and
  - (f) Packet Jitter (frame-delay variation).
- (4) Demonstration that the switch connects to the field, center, and/or communications network as defined in the specifications, plan sets, or as directed by the Engineer and is fully functional in keeping with the specifications.
- (5) Conduct the approved tests and report the results in writing to the Owner's representative.

6. Digital Video Encoder (DVE)/Digital Video Decoder (DVD), Hardened

A. Summary

- (1) Provide Moving Picture Experts Group (MPEG-4) video decompression technology at minimum rates of 20 frames per second (FPS) at Common Intermediate Format (CIF) at a speed of 384 Kilobits per second (Kbps) to a maximum 30 frames per second (FPS) at 3 Megabits per second (Mbps). The DVE encodes (i.e., digitize) analog video at the closed-circuit television (CCTV) surveillance system remote site/s as well as simplex/duplex bi-directional data sub-channels, and upon commands from the BWBOC operator, delivers the selected IP addressed video and data to that sites network interface device (i.e., the Managed Ethernet switch), which transmits and receives data streams to, and from, the operations center (BWBOC) by way of the communications network supplied under a different pay item for this project. The DVD decodes the digital signal back into analog for display on the video display.
- (2) Units contained in this special provision must be installed in the operator console of the BWBOC or the Server/Communications racks located within the Vault Room.

B. Functional and Performance Requirements

- (1) The compliance with the latest edition of the following codes or standards is required:
  - (a) National Television Systems Committee (NTSC);
  - (b) Moving Picture Experts Group (MPEG);
  - (c) Institute of Electrical and Electronic Engineers (IEEE);
  - (d) National Electrical Manufacturers Association (NEMA);
  - (e) National Fire Protection Association (NFPA) 70 - National Electrical Code;
  - (f) National Fire Protection Association (NFPA) 780 - Lightning Protection Code;
  - (g) Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177;
  - (h) Underwriters' Laboratories Standards 96 and 96A (UL); and
  - (i) American National Standards Institute Standard C2 (ANSI).
- (2) Furnish, assemble, fabricate or install materials that are new, corrosion resistant, and in accordance with the details shown on the Plans and in the Specifications.

- (3) Install all the field equipment to be capable of operating in all weather conditions.
- (4) Use identical and completely interchangeable equipment at each field location.
- (5) Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- (6) Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the INTEGRATOR.
- (7) All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the INTEGRATOR as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.
- (8) Transmit compressed digital video and one bi-directional data channels over Internet Protocol (IP) networks.
- (9) Employ the compression algorithms contained in the MPEG-4 technology according to the International Organization for Standardization (ISO) and International Electrotechnical Commission's requirements as detailed in the *ISO/IEC 14496-2:1999* standard for MPEG-4 technology.
- (10) Operate at a minimum of a Common Intermediate Format (CIF) resolution of 20 FPS, and at a maximum of a full D1 resolution of 30 FPS.
- (11) Support both NTSC and PAL.
- (12) Include on-board buffered video memory for protection against potential network disruptions.
- (13) Contain an embedded operating system to provide distributed video processing and support through open network standards.
- (14) Allow vendor interoperability through embedded universal translation.
- (15) Not exceed 250 milliseconds of latency.
- (16) The data sub-channels must be software programmable, directly or over the network, as defined by the Electronic Industries Alliance (EIA) for the EIA-232/672/485 data format, data rate, and data structure (e.g., the number of bits, parity, stop bits, etc.), and IP addressable.
- (17) The network connection must be Ethernet Compliant IEEE 802.3, 802.3u, and 802.3x; 10/100 Mbps, static or DHCP, auto sensing full/half duplex and compatible by way of a Registered Jack (RJ)-45 connector, allowing transmissions over a Category 5e cable to an attached fiber optic media converter, an Ethernet switch, or an IP wireless device.
- (18) The module must be available in card mount and surface mount versions and provide automatic reset as well as transient suppression on all video, data and contact closure input/output connections.
- (19) All Digital Video Encoders (DVE) and Digital Video Decoders (DVD) included within this project and/or contained within the local ITS Device Communications Network or the Primary Ethernet Backbone Communications Network, including MITSC, must be from the same manufacturer and fully interoperable without customization or the addition of appliances within either the remote or primary communications network.
- (20) The DVDs must be equipped with binary network connectors (BNCs) and in compliance with the NTSC standard resolution listed below:
  - (a) D1 NTSC 720 horizontal x 480 vertical; D1 PAL 720 horizontal x 576 vertical;
  - (b) 4CIF NTSC 704 horizontal x 480 vertical; 4CIF PAL 704 horizontal x 576 vertical;
  - (c) 2CIF NTSC 704 horizontal x 240 vertical; 2CIF PAL 704 horizontal x 288 vertical;



- (d) CIF NTSC 352 horizontal x 240 vertical; CIF PAL 352 horizontal x 288 vertical.
- (21) Video Input Specifications
  - (a) The video input performance measures must comply with NTSC and EIA requirements, including the EIA-170 standard, with a composite video of 1.0 to 1.2 volt peak-to-peak (Vp-p).
  - (b) The equipment must have an electrical resistance of 75 ohms ( $\Omega$ ) per 60 hertz (Hz).
- (22) Data Input/Output Specifications
  - (a) All data ports must be compliant with standard EIA-232/672/485 data format. The port's handshaking feature must be software selectable and the data transmission rate of 19.2 kilobytes per second for RS-672/485 and 115.2 Kilobytes per second for RS-232.
  - (b) The serial data output must comply with EIA-232/672/485 data format requirements, and must be software selectable.
- (23) Output Local Area Network (LAN) Connection Specifications
  - (a) The device output connection must be Category 5e shielded twisted pair (STP) network cables and must be compliant with the EIA and Technology Industries Association's (TIA) requirements as detailed in the *EIA/TIA-568-A standard*.
  - (b) The device's output connector port must be Type RJ-45.
  - (c) All Category 5 ports must be standard *EIA/TIA-568-A* pin-outs and must be rated at 10/100 Mbps.
- (24) Indicator/Display Specifications

Two-line scrolling displays or another means of visible, device operational, information dissemination.
- (25) Network Parameter Specifications
  - (a) A minimum data transfer rate of 385 Kbps adjustable to an upper limit of 4.0 Mbps is required.
  - (b) The 10/100BASE-TX, as required in the IEEE 802.3 standards and amendments, must be the network connection to the network devices with Type RJ-45 connectors.
  - (c) Conform to Version 4 of the User Datagram Protocol (UDP), Version 2 of the Internet Group Management Protocol (IGMP), and TCP/IP Version 4.
  - (d) Require the following network protocols: Unicast/Multicast, DiffServ (QoS), UDP, TCP, IP, HTTP, RTSP, RTCP, Telnet, IGMP 2.0, ICMP, DHCP, SNMP, and RTP.
- (26) Mechanical Specifications

120 volts power (plus or minus 10 percent) of alternating current (VAC) must be supplied to the unit. If the device requires operating voltages of less than 120 VAC, the INTEGRATOR must supply the appropriate voltage converter. The maximum power consumption of any DVD is 15 watts.
- (27) Environmental Specifications
  - (a) Have a minimum ambient operating temperature range of -40 to 164.2° Fahrenheit (°F) [-40 to 74° Celsius (C)], the non-condensing relative humidity between 0 to 95 percent, and the temperature inherently compensated to prevent abnormal operation.
  - (b) All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

- (c) Exceed NEMA TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for Operating Temperature, Humidity, Mechanical Shock, Vibration, and Voltage Transient Protection.
- C. Equipment
  - (1) The DVD's and DVE's power connection is through the output of the uninterruptible power supply (UPS).
  - (2) Testing must be as per Manufacturer and in compliance with the Project Acceptance Test Plan.
- 7. Uninterruptible Power Supply (UPS)
  - A. Summary
    - (1) The individual UPS units must allow for battery back up or standby power for specific ITS devices as noted within the plan set or by the Engineer.
    - (2) Install the UPS in the operator console within the BWBOC.
    - (3) Connect the Server, Workstation, Monitors, and DVD's to one UPS.
    - (4) Connect the DLP Display and GigE switch to the other UPS.
  - B. Functional and Performance Requirements
    - (1) The UPS must be capable of operating within an environment with an ambient temperature of -37C° to +74C°.
    - (2) The UPS must have advanced logging/programming capability, real-time status reporting, and fully programmable dry contacts.
    - (3) The UPS dimensions must be 17-inches wide, by 5.25-inches high, by 11-inches deep, nominal.
    - (4) Provide an UPS that is mountable inside a standard EIA 19" Rack.
    - (5) Power Delivery
      - (a) The UPS must be capable of delivering standby power at 120 volts, with an output power rating of 1250 VA, to the plan set specified ITS device within 60 microseconds after the loss of regular power.
      - (b) The UPS must maintain power to the ITS device for a period of 118 minutes at 25C° ambient temperature when the ITS device has a power requirement of 450 watts.
    - (6) The UPS must have the following features:
      - (a) Local Keypad programmability;
      - (b) Backlit LCD display;
      - (c) Six fully programmable dry contacts;
      - (d) Remote access via RS-232 serial;
      - (e) Provides fully interactive program and status reporting;
      - (f) Time/Date Stamp of events and alarms;
      - (g) Field upgradeable from 1250 VA to 2000 VA;
      - (h) Fits in all types of traffic enclosures or can be mounted in an electrical service or custom pedestal;
      - (i) Low harmonic AC sine-wave output;
      - (j) Fully programmable AC threshold voltages; ie. NEMA, Caltrans, or Custom;
      - (k) External connections are front panel accessible;
      - (l) Form C dry relay contacts close on low battery;
      - (m) LED indicator for online, on battery, low battery, overload and fault;
      - (n) RS-232 serial interface;
      - (o) Intelligent Boost Operation for brownout;
      - (p) Option power conditioning;
      - (q) Back up power provide by sealed battery modules;
      - (r) Temperature-concentrated charging;

- (s) Noise suppression, FCC Class A; and
- (t) Meets Caltrans BBS specifications.
- (7) Electrical
 

(a) Input/Output Voltage (VAC) nominal	120
(b) Input/Output Frequency (Hz) nominal	60
(c) Input Current (A) maximum	12/20
(d) Input Voltage Variation	-23% to +17%
(e) Voltage Waveform	Sine
(f) Typical Line Efficiency	95%-97%
(g) Typical Output Voltage THD	<3%
(h) Maximum Charge Current (ADC)	6/10
(i) Maximum Transfer Time (ms)	60
(j) Audible Noise at 1m (dBA)	<32
(k) Lightning/Surge Protection	ANSI C.62.45 Cat A & B
- (8) Environmental
  - (a) Except as stated otherwise herein, within the plan set, and/or in the Contract, the UPS must meet all specifications during and after being subjected to an ambient operating temperature range of 0° to +40° Celsius (C) and a non-condensing relative humidity of 10 to 80 percent.
  - (b) The design must be inherently temperature compensated to prevent abnormal operation.
  - (c) The circuit design must include such compensation as is necessary to overcome adverse effects due to temperatures in the specified environmental range.
- (9) Mechanical
  - (a) All external screws, nuts, and locking washers must be stainless steel.
  - (b) The INTEGRATOR must not use self-tapping screws unless the Engineer provides prior approval.
  - (c) All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

### **c. Demolition, Removal, Restoration and Construction.**

#### **1. General Requirements**

- A. Certificate of Qualification demonstrating the Installer/Integrator's required experience is to be issued to the Engineer for approval prior to any Notice to Proceed. Minimum qualifications requirement for the Installer/Integrator are three years in the business of installation and integration of Ethernet systems and a minimum of three similar projects completed within the last three years, with project references.
- B. Prior to shop drawings, a pre-construction site survey must be conducted by a factory trained and certified representative. Provide to the Engineer a construction plan identifying work items, schedule and utility and/or owner coordination. The site survey and construction plan must be designed to identify the exact locations and details for each installation. The site survey report and construction plan must be submitted to the Engineer for approval including specific location and detail information before commencement of work.
- C. Coordinate with local utility companies to move, add, change or delete services as required to facilitate a timely, cost effective, and efficient implementation
- D. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

- E. Store equipment in spaces with environments that are controlled within the manufacturer's ambient storage temperature and humidity tolerances for non-operating equipment.
- F. Demolish existing work areas, furniture or other obstacles in order to provide the modifications contained within this special provision.
- G. Remove all demolished/obsolete materials.
- H. Restore walls, floor, ceiling, lighting, doors, electrical, plumbing, fire, etc to finished or pre-demolition state as per the approved construction plan.
- J. Quality Control and Testing

- (1) INTEGRATOR Test Result Specifications

To meet all applicable requirements, the INTEGRATOR must supply documentation of all test results to the Engineer prior to approval of the system.

- (2) Post Installation Testing Specifications

The INTEGRATOR must:

- (a) Perform local field operational tests at the device field site and from each Center.
- (b) Develop an Acceptance Test Plan and perform acceptance testing in accordance with the plan and the test procedures detailed herein, within the plan set, and/or as directed by the Engineer.
- (c) Verify that physical construction has been completed as detailed herein, within the plan set, and/or in the Contract;
- (d) Check power supply voltages and outputs;
- (e) Connect devices to the power sources;
- (f) Verify installation of specified cables and connections between the UPS and the ITS device;
- (g) Verify the presence and quality of ITS device operation while operating on standard power; and
- (h) Test and verify the proper installation and operation of the fully charged UPS by disconnecting the power to the ITS device that is being supported by the UPS.
- (i) Observe the successful operation of the ITS device on the battery back up power of the UPS.

- 2. Documentation Required

- A. Provide the necessary documentation as proof of qualifications of the Ethernet electronic equipment manufacturer.
- B. Provide the necessary documentation as proof of qualifications of the installer/integrator.
- C. Provide a complete detail cut-sheet on all equipment under this Special Provision.
- D. Highlight each individual item on cut-sheet.
- E. Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- F. Provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- G. Provide a shop drawing showing all devices and their connectivity.
- H. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

### 3. Equipment

#### A. General

- (1) Throughout the project, the INTEGRATOR must retain workers with networking knowledge (i.e., protocols, network-addressing schemes) for equipment set-up. The personnel must have the ability and equipment to field verify equipment locations to ensure reliable communication links (e.g., fiber testing equipment).
- (2) Use shielded and grounded coaxial and twisted-pair cable for inter-shelf Ethernet Backbone of equipment.
- (3) Provide power and data cables and connectivity to all rooftop equipment provided under separate pay items included with this project.
- (4) Provide surge protector that protects the power conductor and control conductor (including return conductors).
- (5) Transient voltages, surges, and sags must not affect the equipment operations.
- (6) The equipment must meet all the requirements in Section 2.1.4 "Power Interruption" of the National Electrical Manufacturer's Association (NEMA) standard TS-1 for traffic control.
- (7) Refer to Special Provision for Grounding and Bonding for additional requirements.
- (8) The equipment must be designed such that the failure of it is to not cause the failure of any other unit of equipment.
- (9) Submit modular equipment, where applicable to allow major portions to be readily replaced in the field.
- (10) Design equipment for ease of maintenance. All equipment parts must be readily accessible for inspection and maintenance. Test points must be provided for checking essential voltages and waveforms.
- (11) PC Workstations and Server equipment must be interoperable. Latest released software versions, patches, releases, license requirements, and related configuration options are all the responsibility of the INTEGRATOR.
- (12) Provide and install all available software upgrades through final acceptance.
- (13) Furnish and install data and video patch cords, as well as the required power adapter as an appurtenance to the communications devices.
- (14) Furnish all operator and/or user's manual and any applicable firmware and software
- (15) Preliminary connectivity diagram provided in Figure 2 below. Revise the diagram as necessary based on site survey and include with construction plan.

#### Installation

- (1) Submit a site detail plan identifying location and orientation of the operator console in relation to the DLP display, existing doors, existing windows and existing lighting to the Engineer for approval. Revise and resubmit as necessary for final approval
- (2) Site detail plan must be approved before installation.
- (3) The Site detail plan must include the core boring process required to interconnect the video display units, the console and the server/communications racks. The cabling associated with this interconnection is required to be plenum rated as required within the NEC.
- (4) The INTEGRATOR must furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable specifications, standards, and requirements before the system is considered for acceptance. It is the INTEGRATOR's responsibility to ensure that all features, functions, and

performance measures detailed herein, within the plan set, and/or in the Contract are provided.

- (5) All materials furnished, assembled, fabricated, or installed as detailed herein, within the plan set, and/or in the Contract must be new products obtained from the manufacturer or reseller. The INTEGRATOR must not use reconditioned equipment or system components. The materials, equipment, and components must be commercial off-the-shelf (COTS) products.
- (6) Cable runs of longer than 25 feet may be fabricated to length on site provided that all specification requirements other than COTS requirements are met. Splices are not allowed in any cables.
- (7) Power, audio, video and data wires and cables must be installed into wall or above ceiling. Do not leave wires and cables exposed.
- (8) The INTEGRATOR must furnish all tools, equipment, materials, supplies, and manufactured hardware, and must perform all operations and equipment integration necessary to provide complete, fully operational equipment as specified herein, within the plan set, and/or in the Contract.
- (9) Install the GigE switch meeting all specifications, standards and material requirements contained herein, power supply cord or adapter, all mounting hardware, Manufacturers Operation Manual, required testing results, manufacturers technical specification, and the cost of all materials, training, warranty, equipment, and all appurtenances necessary to the complete installation of the unit.
- (10) Perform all setup, programming, focusing adjustments, calibrations, and internal set-up procedures recommended by the equipment manufacturer. The INTEGRATOR must develop the configuration of the GigE switch to provide for full system performance as described in this specification, identified in the plans, or as directed by the Engineer. The INTEGRATOR must develop a configuration plan and submit the plan to the Engineer for approval before switch configuration may begin. The plan must identify the following minimum configuration parameters:
  - (a) IP Addressing;
  - (b) STP, RSTP setup;
  - (c) Port configuration;
  - (d) Routing setup;
  - (e) IP Multicast setup;
  - (f) Network topology;
  - (g) VLAN;
  - (h) Prioritization; and
  - (i) QoS configuration.
- (11) Mark cables, regardless of length, with wrap-around number or letter cable markers at both ends. These labels must be self-laminating to ensure durability. Marking codes used on cables must correspond to codes shown on the drawings, and/or the written documentation of the "as-built" system the INTEGRATOR must supply.
- (12) The INTEGRATOR must securely install and mount the unit(s) as specified in the plans in the BWBOC. It is the INTEGRATOR's responsibility to ensure that the units submitted and supplied as part of this project are capable of being installed in operator console without adversely affecting the operations or maintenance of the other equipment installed under this project. It is also the INTEGRATOR's responsibility to ensure adequate power meeting the manufacturer's recommendations is provided for the installed GigE switch. In all cases, the

INTEGRATOR must submit plan and material details to the Engineer for approval prior to ordering materials or proceeding with installation.

- (13) Install operator console as approved.
- (14) Tilt and manipulate display to provide best viewing by operator.
- (15) Configure display to receive and transmit A/V signals as instructed by the Engineer.
- (16) Furnish, install and integrate all available software upgrades through final acceptance.
- (17) Furnish, install, and test data and video patch cords, as well as the required power adapter as an appurtenance to the DVD.
- (18) Modify existing lighting to accommodate new DLP display.

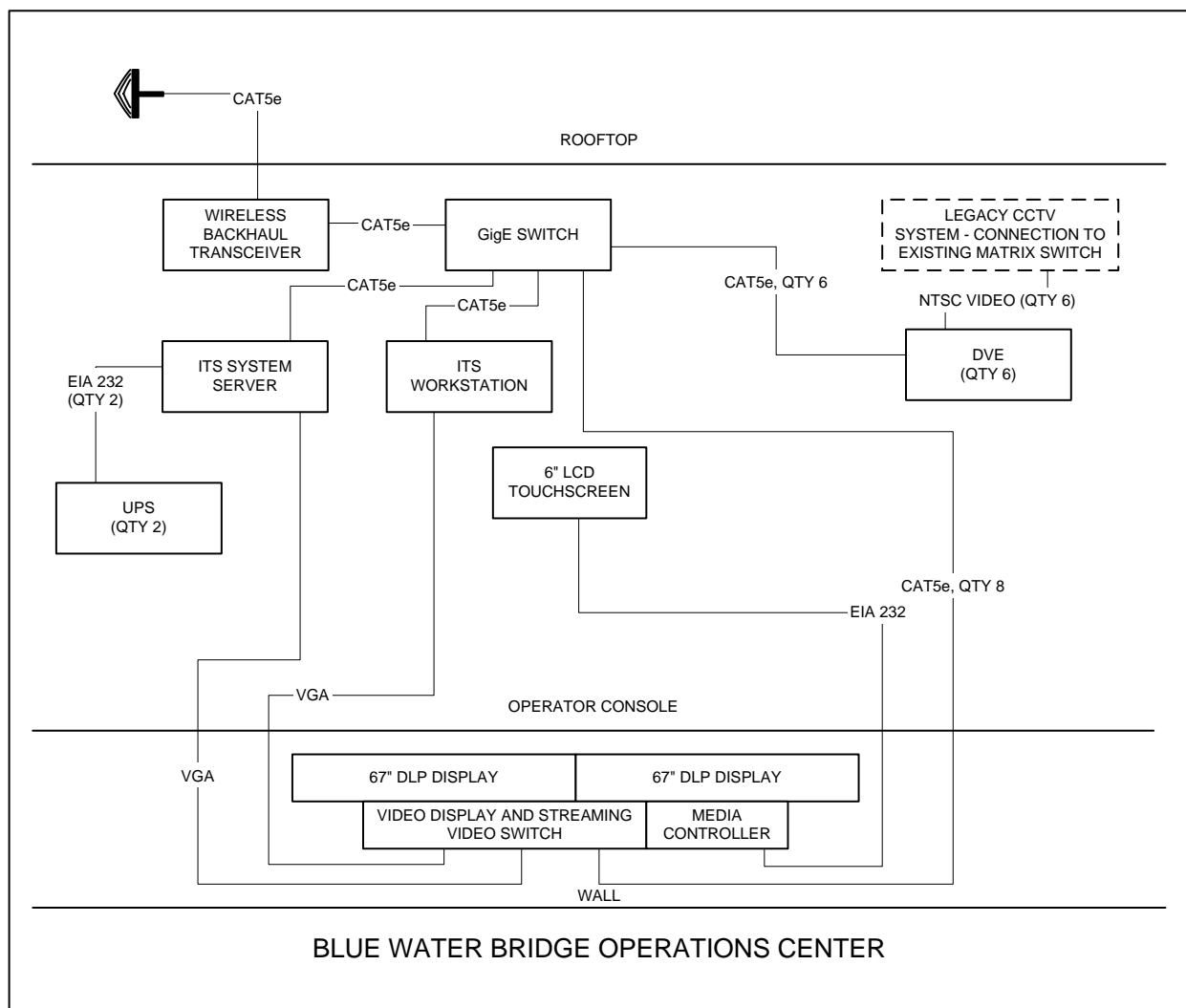


Figure 2. Preliminary Connectivity Diagram

## B. Integration Legacy Servers

- (1) Within the Blue Water Bridge Operations Control room there exist six (6) legacy servers. Two of these servers, Toll Operations and Automatic Toll Collection will be physical relocated to the proposed Server Rack within the Vault Room adjacent to the Operations Room (no server change out or modification is required). Four of the servers are legacy DMS/VMS/CMS and lane indicator servers. These Four (4) servers are operating on Windows 2000. The INTEGRATOR is to migrate, aggregate and integrate these four server's systems into the proposed ITS System Server. This will require the upgrade of the operating systems for each of these legacy servers to the new operating system furnished in the proposed ITS System Server. This migration, aggregation and integration of these legacy servers is part and parcel of the System Integration function within the Blue Water Bridge Operation Room Lump Sum.
- (2) The INTEGRATOR is required to migrate and integrate the legacy CCTV system into the proposed ITS System Server. This integration will include those functions that enable the Operator to include the legacy CCTV's within the ITS operating system. Those CCTV that are not NTCIP enabled will continue to operate utilizing that CCTV's operating protocol. The INTEGRATOR will be responsible for the integration of protocol drivers (if required) for all legacy CCTV thus enabling operator control of the legacy CCTV system through the Surveillance 360 Software platform. The ITS System Server will be installed within the Server Rack located within the Vault Room adjacent to the Operations Room as depicted within the Plans. This migration and integration of the legacy CCTV System is part and parcel of the System Integration function within the Blue Water Bridge Operation Room Lump Sum.

#### Software

- (1) Configure applicable (CCTV, DMS) management software on the ISS and on the ITS Workstation to recognize the entire field installed devices in the area of work. DMS control to include existing BWBOC DMS. CCTV control to include existing and proposed MITS CCTV and existing BWBOC CCTV.
- (2) After all software is configured, the INTEGRATOR must test each application to verify all present ITS functionality is available from the BWBOC to operate and control all devices contained within the scope of this project.

#### C. Power Requirements

- (1) The equipment must meet all of its specified requirements when the input power is 120/240 volts (plus or minus 20 VAC), 60 Hz (plus or minus 3 Hz). The equipment must be powered from the output of the uninterruptible power supply (UPS).
- (2) The maximum power required must not exceed 700 watts

#### D. Testing

- (1) BWBOC network equipment must be tested per the Project Acceptance Test Plan and the manufacturer's testing/operational specifications.
- (2) Provide a minimum of 30 days prior to commencing project acceptance testing, a Project Acceptance Test Plan and revise said plan until it meets the approval of the Engineer.
- (3) Communications testing between all connected devices must be provided as indicated on drawings. Testing must include connectivity, bandwidth, load and fault recovery of connected devices.
- (4) At each device included in the work of this project, the INTEGRATOR must test and demonstrate all features of control and operation. This is to include functioning of the CCTV Cameras, DMS, as well as demonstrating full diagnostic capability of the Ethernet network and other installed network devices.



4. Warranty

The BWBOC modifications including all renovation of the BWBOC, servers, UPS, display and console/chair will carry a manufacturer's standard warranty (parts, software and labor) of 1-year, unless otherwise noted within this Special Provision, from the date of final acceptance. The Ethernet switch will carry a manufacturer's standard warranty of 5-years.

**d. Measurement and Payment.** The completed work will be paid for at the contract unit price for the following contract item (pay item):

<b>Contract Item (Pay Item)</b>	<b>Pay Unit</b>
BWBOC Modifications.....	Lump Sum

The work for constructing the **BWBOC Modifications** includes all labor, equipment, and materials to construct the item.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**ITS CABINET**

METRO: MM

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03-15-2006

**a. Description**

1. This project consist of the following:

**A. ITS Cabinet.**

- (1) This work consists of furnishing, populating with equipment described in this TSP (including burn-in and testing as described in the Statement of Services), field integration and warranty of 336S Special Pole Mounted, and 332 Special Ground Mounted, ITS Cabinets. The ITS Cabinet provides an environmentally secure enclosure to house ITS field device equipment, subsystems, ITS network communications equipment and surge protection. The cabinet must be designed for the explicit use of housing and protecting sensitive electronic equipment (Encoders, Ethernet switches 10/100 Mbps, media converters, port/terminal servers, wireless communications equipment, and other related components, etc.) within a controlled environment necessary for the proper operation of installed electronic equipment.
- (2) The ITS Cabinets and foundation/poles will be installed in the field by a "brick and mortar" Contractor. The Contractor is required to coordinate with the Integrator and the System Manager for the pickup of the completely populated, burned-in and tested ITS Cabinets. Once the cabinets are installed the Integrator will provide field integration into the ITS network, testing and burn-in. Upon completion and final acceptance testing and burn-in the Integrator will provide the specified warranty.

**B. 10/100 Ethernet Switch**

The work consist of the furnishing, installation within the ITS Cabinet, integrating and testing of the device-level, environmentally hardened, managed field Ethernet switch (MFES). The MFES must be industrial-grade Ethernet switch that provides wire-speed Ethernet/Fast Ethernet (10/100 mbps) connectivity from the remote ITS devices to the ITS network trunk interconnection point. The furnished MFES must be fully compatible and interoperable with the ITS network trunk Ethernet network interface.

**C. Digital Video Encoder**

The work consist of the furnishing, installing within the ITS Cabinet, integrating and testing of the digital video encoders, hardened (DVEs), providing Moving Picture Experts Group (MPEG-4) video compression technology at minimum rates of 20 frames per second (FPS) at Common Intermediate Format (CIF) at a speed of 384 Kilobits per second (Kbps) to a maximum 30 frames per second (FPS) at 3 Megabits per second (Mbps). This ITS device encodes (i.e., digitize) analog video at the

closed-circuit television (CCTV) surveillance system remote site/s as well as simplex/duplex bi-directional data sub-channels. Upon commands from the transportation management center (MITSC) operators, it delivers the selected IP addressed video and data to that sites network interface device (i.e., the Managed Ethernet switch), which transmits and receives data streams to, and from, the MITSC. The MITSC is also known as the network head-end, by way of the communications hub/s and/or the communications node/s interconnected to the remote surveillance system(s).

#### D. Terminal Server

The work consist of the furnishing, installation within the ITS Cabinet, testing and integration of the hardened terminal device server/s (TDS), all required communications cable, patch cords and jumpers. The TDS must provide Ethernet to Serial data communications via category 5e copper transmission medium. The TDS role must be to provide an Ethernet connection for field device circuits remaining on Twisted Wire Pair (TWP) interconnect.

### 2. General

The Integrator must furnish, install, integrate and test all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

### 3. Summary

- A. The payment process including partial payment will be governed by Section 109 of the *Michigan Department of Transportation Construction Manual*.
- B. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the Integrator as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- C. The Integrator must furnish and install complete with all accessories the required communications pathways.

### 4. Requirements of Regulatory Agencies

- A. The compliance with the latest edition of the following codes or standards is required:
- B. *National Television Systems Committee (NTSC)*
- C. *Moving Picture Experts Group (MPEG)*
- D. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*
- E. *National Electrical Manufacturers Association (NEMA)*.
- F. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
- G. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
- H. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
- I. *Underwriters' Laboratories Standards 96 and 96A (UL).*
- J. *Underwriters' Laboratories Standards 60950 and 508 (UL).*
- K. *American National Standards Institute Standard C2 (ANSI).*

### 5. General Requirements

- A. General

- (1) Furnish, assemble, fabricate or install materials that are new, corrosion resistant, and in accordance with the details shown on the Plans and in the Specifications.
- (2) Install all the field equipment in the ITS Cabinet and perform field integration to be capable of operating in all weather conditions.
- (3) Use identical and completely interchangeable equipment in all ITS Cabinet/s, Communications Hubs and operations centers, including MITSC.
- (4) Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- (5) Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- (6) All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

B. ITS Cabinet

No additional general requirements

C. 10/100 Ethernet Switch

No additional general requirements

D. Digital Video Encoder

No additional general requirements

E. Terminal Server

- (1) All electrical equipments must operate on 120 volts, 50/60 Hz electricity. The Integrator must provide appropriate DC conversion for any equipment requiring DC power.
- (2) All field equipment must perform to stated specifications over a temperature range of -40° to 165° F and a humidity range of 0 percent to 95 percent relative non-condensing.

6. Functional Specifications

A. ITS Cabinet

(1) Size

- (a) 336 Special outside dimension: approximately 46-inches (height) x 24-inches (width) x 24-inches (depth).
- (b) 332 Special outside dimensions: approximately 66-inches (height) x 24-inches (width) x 30-inches (depth).
- (2) Foundation (Provided by Others)
- (3) Finish: Powder coated off-white.
- (4) Lighting: A door activated 20W cool white fluorescent light is required.

- (5) Alarm: A door activated "open door" alarm or notification which will alert the operations center that the ITS Cabinet door is open.
- (6) Electrical Outlets: One duplex ground fault interrupter (GFI) and one standard duplex receptacle is required.
- (7) Equipment Racks: One 19" equipment rack, adjustable 4-post design, with 5/8-inches -5/8-inches -1/2-inches spacing with holes tapped for #12-24 screws, a rack-mounted drawer with laptop tray is required with the rack system.
- (8) Air Filtration: Air filtration by way of a reusable-washable filter placed over the air intake vent.
- (9) Power Distribution: Power distribution for the cabinet is to be governed by a 30A main breaker with branch distribution circuits to the rack mounted equipment, lighting, and outlets.
- (10) Uninterruptible Power Supply (UPS): Each cabinet will be furnished with a rack mounted UPS with an input voltage of 120 volts and an output voltage of 120 volts. The output power capacity of the UPS will be 1400VA/1050 watts and included a serial interface port for management.
- (11) Surge Protection
  - (a) Primary surge suppression consists of a wall or flush mounted unit with 12 AWG terminals with a maximum 80kA (8/20 $\mu$ s), protecting lines L-N, L-G, L-L, and N-G. Environmental requirements: ambient temperatures of -40°F to 185°F (-40°C to 85°C working) and 95% RH (non-condensing). Approximate dimensions: 4.5-inches x 2.9-inches x 2.3-inches.
  - (b) A nine-outlet (seven switched, two un-switched) rack mounted surge suppressor unit is required. The maximum surge current: 84kA with a load current of 15A or 20A at a working voltage of 120V 50/60Hz.
  - (c) A 19" DIN Rail kit is required with enough space for 32 modular surge suppressor devices (RJ11, RJ45, or BNC connector type) attached meeting the following criteria: ambient temperature of -40°F to 185°F (-20°C to 85°C working) and 95% RH (non-condensing). Dimensions: 5.04-inches (height) x .99-inches (width) x 2.25-inches (depth).
  - (d) The required number and type of modular surge suppressor devices are to be installed on the DIN Rail and wired to the devices that the surge suppressors protect. The number and type of modular surge suppressor devices installed is determined by the number and type of the components contained within each cabinet.
- (12) Common Grounding System: A floor mounted 12-position ground bar is required in each cabinet.

#### B. 10/100 Ethernet Switch

- (1) Provide 99.999 percent error free operation; EIA-compatible Ethernet data communication by way of wireless Ethernet transmission; and a Category 5e copper shielded twisted pair (STP) transmission medium. A switched Ethernet connection for each remote ITS field device location is to be provided.
- (2) Must be mountable inside a control cabinet, CCTV remote site cabinet or other field cabinet without the need for special environmental conditioning. Power supply must be internal to the MFES. The MFES will have no moving parts, i.e. fans, and be completely of solid-state construction. The MFES must be resistant to all electromechanical interference (EMI). The switch must be installed in such

a way allowing the MFES to be fully accessible by field technicians. The switch will support full/half duplex Ethernet communication.

- (3) Manufactured in compliance with the following IEEE networking standards for Ethernet communication:
  - (a) *IEEE-802.1D, Information Technology – Telecommunications and Information Exchange Between Systems – Local Area Networks – Media Access Control (MAC)*: MAC bridges used with the Spanning Tree Protocol (STP);
  - (b) *IEEE-802.1Q, Local and Metropolitan Area Networks – Virtual Bridge Local Area Networks*: port-based virtual local area network (VLAN);
  - (c) *10BASE-T; IEEE-802.3, Information Technology – Local and Metropolitan Area Networks – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*
  - (d) *IEEE-802.3u, Supplement to CSMA/CD Access Method and Physical Layer Specifications: Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment, and Repeater for 100 mbps Operation, Type 100BASE-T: 100BASE-TX/100BASE-Fiber Transmission (FX)*;
  - (e) *IEEE-802.3x, Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation*: flow control; and
  - (f) *IEEE-802.1W Information Technology – Telecommunications and Information Exchange Between Systems – Local Area Networks – Media Access Control (MAC)*: Amendment 2: MAC bridges used with the Rapid Spanning Tree Protocol (RSTP).

#### C. Digital Video Encoder

- (1) Transmit compressed digital video and one bi-directional data channels over Internet Protocol (IP) networks.
- (2) Employ the compression algorithms contained in the MPEG-4 technology according to the International Organization for Standardization (ISO) and International Electrotechnical Commission's requirements as detailed in the *ISO/IEC 14496-2:1999* standard for MPEG-4 technology.
- (3) Operate at a minimum of a Common Intermediate Format (CIF) resolution of 20 FPS, and at a maximum of a full D1 resolution of 30 FPS.
- (4) Support both NTSC and PAL.
- (5) Include on-board buffered video memory for protection against potential network disruptions.
- (6) Contain an embedded operating system to provide distributed video processing and support through open network standards.
- (7) Allow vendor interoperability through embedded universal translation.
- (8) Not exceed 250 milliseconds of latency.
- (9) The data sub-channels must be software programmable, directly or over the network, as defined by the Electronic Industries Alliance (EIA) for the EIA-232/422/485 data format, data rate, and data structure (e.g., the number of bits, parity, stop bits, etc.), and IP addressable.
- (10) The network connection must be Ethernet Compliant IEEE 802.3, 802.3u, and 802.3x; 10/100 Mbps, static or DHCP, auto sensing full/half duplex and compatible by way of a Registered Jack (RJ)-45 connector, allowing transmissions over a Category 5e cable to an attached fiber optic media converter, an Ethernet switch, or an IP wireless device.

- (11) The module may either be card mount or surface mounted versions and provide automatic reset as well as transient suppression on all video, data and contact closure input/output connections.
- (12) Video encoders located within surveillance system, remote sites must be stand-alone surface mount versions.
- (13) All DVEs and Digital Video Decoders (DVDs) included within this project and/or contained within the local ITS Device Communications Network or the Primary Ethernet Backbone Communications Network must be from the same manufacturer and fully interoperable without customization or the addition of appliances within either the remote or primary communications network.

#### D. Terminal Server

- (1) Provide 99.999 percent error-free operation; Ethernet data communication by way of an EIA-certified Category 5e copper transmission medium.
- (2) Be furnished and installed where the remote ITS device only has Serial Data output, such as EIA-232/422/485.
- (3) Be mountable inside a control cabinet, CCTV remote site cabinet or other field cabinet without the need for special environmental requirements.
- (4) Be serial data type input switch selectable, EIA-232/422/485.
- (5) Be resistant to all electromechanical interference (EMI).
- (6) Be capable of fitting inside the cabinet in a secure location and fully accessible by field technicians.
- (7) Support full duplex 10/100 Mbps Ethernet communication.

### 7. Performance Specifications

#### A. ITS Cabinet

None described

#### B. 10/100 Ethernet Switch

- (1) The STP healing rate must meet or exceed specifications published in the *IEEE 802.1D* standard.
- (2) The RSTP healing rate must meet or exceed specifications published in the *IEEE 802.1w* standard.
- (3) The switch must support a port-based VLAN.
- (4) The VLAN must meet or exceed specifications as published in the *IEEE 802.1Q* standard.
- (5) A minimum 4K VLAN address table is required.
- (6) The forwarding/filtering rate is to be 14,880 packets per second (pps) for 10 mbps and 148,800 pps for 100 mbps.
- (7) The switch MAC address table is to be a minimum 4K.
- (8) The switch is to support, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).
- (9) The switch must be SNMP management capable.
- (10) Access via the resident EIA-232 management port.
- (11) Access via a telecommunications network (Telnet) or by file transfer protocol (FTP).
- (12) RMON support for the Ethernet agent.

- (13) Capable of upgrading to SMON if necessary.
- (14) The switch must support FTP.
- (15) The switch must support the network time protocol (NTP) and simple network time protocol (SNTP).
- (16) The MFES must have a minimum mean time between failures (MTBF) of 10 years.

#### C. Digital Video Encoder

- (1) The DVEs must be equipped with binary network connectors (BNCs) and in compliance with the NTSC standard resolution listed below:
- (2) D1 NTSC 720 horizontal x 480 vertical; D1 PAL 720 horizontal x 576 vertical.
- (3) 4CIF NTSC 704 horizontal x 480 vertical; 4CIF PAL 704 horizontal x 576 vertical.
- (4) 2CIF NTSC 704 horizontal x 240 vertical; 2CIF PAL 704 horizontal x 288 vertical.
- (5) CIF NTSC 352 horizontal x 240 vertical; CIF PAL 352 horizontal x 288 vertical.

#### 8. Terminal Server

None provided

### b. Materials.

#### 1. ITS Cabinet

- A. R-4 insulation to control the effect of environmental conditions is required on interior sides, top and both doors.
- B. 1/8", 5052 Aluminum construction with white powder coat finish is required.
- C. Doors rated NEMA 3R with neoprene gasketing and heavy-duty 3-point hardware on all doors is required.
- D. All hinges are to be 1/8" aluminum with stainless steel piano hinge or continuous door length stainless steel hinges.

#### 2. 10/100 Ethernet Switch

##### A. Copper Port Specifications

- (1) The MFES must be furnished with eight (8) copper ports. All copper ports are to be Type RJ-45 and auto-negotiate for speed (i.e., 10/100Base) and duplexity (i.e., full or half). All 10/100BASE-TX ports are to meet the Category 5 specifications and be compliant with standard *EIA/TIA-568-A, Commercial Building Telecommunications Cabling Standard*, pin-outs.
- (2) All Category 5e cable shielded twisted pair (STP) network cables must be *EIA/TIA-568-A* compliant.

##### B. Mechanical Specifications

- (1) 120 volts power of alternating current (VAC) must be supplied to the unit. If the device requires operating voltages of less than 120 VAC, the Integrator is required to supply the appropriate voltage converter. The maximum power consumption of the switch must be 20 watts.
- (2) The unit must contain diagnostic light emitting diodes (LEDs). These indicators



must include link, TX, RX, speed (for copper 10/100 mbps ports only), and power LEDs.

C. Environmental Specifications

- (1) The equipment must meet all specifications during and after being subjected to an operating ambient temperature range of -40 to 85°C, or -40 to 185°F, and with a non-condensing humidity of 0 to 95 percent.
- (2) All system components in environmental housings must comply with the applicable *NEMA TS 1 1998, Traffic Controller Assemblies with NTCIP Requirements*.

3. Digital Video Switch

None

A. Video Input Specifications

The video input performance measures must comply with NTSC and EIA requirements, including the EIA-170 standard, with a composite video of 1.0 to 1.2 volt peak-to-peak (Vp-p). The equipment must have an electrical resistance of 75 ohms ( $\Omega$ ) per 60 hertz (Hz).

B. Data Input/Output Specifications

- (1) All data ports must be compliant with standard EIA-232/422/485 data format. The port's handshaking feature must be software selectable and the data transmission rate of 19.2 kilobytes per second for RS-422/485 and 115.2 Kilobytes per second for RS-232.
- (2) The serial data output must comply with EIA-232/422/485 data format requirements, and must be software selectable.
- (3) The device output connection must be Category 5e shielded twisted pair (STP) network cables and must be compliant with the EIA and Technology Industries Association's (TIA) requirements as detailed in the *EIA/TIA-568-A standard*.
- (4) The device's output connector port must be Type RJ-45.
- (5) All Category 5 ports must be standard *EIA/TIA-568-A* pin-outs and must be rated at 10/100 Mbps.

C. Indicator/Display Specifications

Two-line scrolling displays or another means of visible, device operational, information dissemination.

D. Network Parameter Specifications

- (1) A minimum data transfer rate of 385 Kbps adjustable to an upper limit of 4.0 Mbps is required.
- (2) The 10/100BASE-TX, as required in the IEEE 802.3 standards and amendments, must be the network connection to the network devices with Type RJ-45 connectors.
- (3) Conform to Version 4 of the User Datagram Protocol (UDP), Version 2 of the Internet Group Management Protocol (IGMP), and TCP/IP Version 4.
- (4) Require the following network protocols: Unicast/Multicast, DiffServ (QoS), UDP, TCP, IP, HTTP, RTSP, RTCP, Telnet, IGMP 2.0, ICMP, DHCP, SNMP, and RTP.

E. Mechanical Specifications

120 volts power of alternating current (VAC) must be supplied to the unit. If the device requires operating voltages of less than 115 VAC, the Integrator must supply the appropriate voltage converter. The maximum power consumption of any DVE is 15 watts.

F. Environmental Specifications

- (1) Have a minimum ambient operating temperature range of -40 to 164.2° Fahrenheit (°F) [-40 to 74° Celsius (C)], the non-condensing relative humidity between 0 to 95 percent, and the temperature inherently compensated to prevent abnormal operation. All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.
- (2) Exceed NEMA TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for Operating Temperature, Humidity, Mechanical Shock, Vibration, and Voltage Transient Protection.

4. Terminal Server

A. Copper Port Specifications

- (1) Include five (5) copper ports, one consisting of a copper fast Ethernet port. All copper must be Type RJ-45. The Ethernet 10/100 BASE-TX port must auto negotiate for speed (10/100) and duplexity, and be compliant with standard *EIA/TIA-568-A, Commercial Building Telecommunications Cabling Standard*, pinouts.
- (2) All Category 5e, shielded twisted pair (STP) network cables must be compliant with the *EIA/TIA-568-A*.

B. Performance Specifications

- (1) The TDS must have the ability of remote management features, including diagnostics, auto-discovery tool, data security via SSH v2, SSLv3/TLSv1, port buffering, and full SNMP management. The SSLv3/TLSv1 must include support for AES 256-bit strong encryption as defined in IETF/RFC 3268 and FIPS 197.
- (2) The TDS must provide full control of serial parameters (DTR, DCD, DSR, CTS, RTS), baud rates (50-230400), parity (None, Even, Odd, Mark, Space), stop bits (1,2). RTS toggle for half-duplex emulation must be supported.
- (3) The forwarding/filtering rate must be 14,880 packets per second (pps) for 10 Mbps and 148,800 pps for 100 Mbps.
- (4) The TDS must include simple network management protocol (SNMP), MIBII and EIA-232 MIBS.
- (5) The TDS must have a minimum mean time between failures (MTBF) of 10 years.

C. Mechanical Specifications

- (1) Operation and power must be supplied to the unit with 120 volts of alternating current (VAC). The equipment must have a minimum operating input of 100 VAC and a maximum operating input of 240 VAC.
- (2) The unit must contain diagnostic light emitting diodes (LEDs). These indicators must include link, TX, RX, speed (for cat 5 ports only), and power LEDs.

D. Environmental Specifications

- (1) The equipment must meet all specifications during and after being subjected to an operating ambient temperature range of -40 to 165°F, and with a non-condensing humidity of 0 to 95 percent.
- (2) All system components in environmental housings must comply with the applicable *NEMA TS 2, Traffic Controller Assemblies with NTCIP Requirements*.

E. Equipment

- (1) Provide and install all available software upgrades through final acceptance.
- (2) Furnish and install data patch cords as an appurtenance to the TDS, as well as the required power adapter as an appurtenance to the TDS.
- (3) Furnish the TDS operator or user's manual and any applicable firmware.
- (4) Each device must have a unique address, which is changeable by CLI settings. The unit must respond to the central command only if it is addressed.

c. Construction.

1. General Requirements

A. ITS Cabinet

- (1) Prior to turning the ITS Cabinet over to the "brick and mortar" contactor for installation, the Integrator is to deliver to the Engineer test documentation for each ITS cabinet including individual component test data and a required 72-hour burn-in documentation for each fully equipment integrated cabinet.
- (2) The Integrator is to furnish to the Engineer, and include a hard copy within the cabinets document drawer, a wiring diagram, serial/model numbers, and IP addressing scheme for all electronic components within each cabinet. The Integrator will furnish to the MDOT an asset management data base in electronic format which will include all subsystems and systems furnished by the Integrator.
- (3) Mounting of the cabinet is by way of a minimum of four stainless steel straps as directed by the manufacturer and approved by the Engineer.

B. 10/100 Ethernet Switch

- (1) Furnish, install and integrate all available software upgrades through final acceptance.
- (2) Furnish, install, and test all components including patch cords and jumpers, as well as required power adapter as an appurtenance to the MFES.
- (3) Complete initial ITS tests prior to implementation to ensure complete the specified operation as required within the Scope of Services.
- (4) Coordinate with local utility companies to move, add, change, or delete services as required to facilitate a timely, cost effective, and efficient implementation.

C. Digital Video Encoder

- (1) Furnish, install and integrate all available software upgrades through final acceptance.
- (2) Furnish, install, and test data and video patch cords, as well as the required power adapter as an appurtenance to the DVE.
- (3) Complete initial ITS tests prior to implementation to ensure the specified operation as required within the Scope of Services.

- (4) Coordinate with local utility companies to move, add, change, or delete services as required to facilitate a timely, cost effective, and efficient implementation.

D. Terminal Server

None

2. Documentation Requirement

A. ITS Cabinet – None

B. 10/100 Ethernet Switch

- (1) Prior to procurement the Integrator will provide a complete detail cut-sheet on all equipment proposed under this Special Provision for approval by the Project Manager.
- (2) Highlight each individual item on cut-sheet.
- (3) Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- (4) Provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- (5) Provide a shop drawing showing all devices and their connectivity.
- (6) Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

C. Digital Video Encoder

- (1) Prior to procurement the Integrator will provide a complete detail cut-sheet on all equipment proposed under this Special Provision for approval by the Project Manager.
- (2) Highlight each individual item on cut-sheet.
- (3) Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- (4) Present a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- (5) Make available shop drawings showing all devices and their connectivity.
- (6) Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

D. Terminal Server

- (1) Prior to procurement the Integrator will provide a complete detail cut-sheet on all equipment proposed under this Special Provision for approval by the Project Manager.
- (2) Highlight each individual item on cut-sheet.

### 3. Equipment

#### A. ITS Cabinet – None

#### B. 10/100 Ethernet Switch

- (1) The MFES's power connection is through the output of the uninterruptible power supply (UPS).
- (2) Testing must be as per Manufacturer and in compliance with the Project Acceptance Test Plan.

#### C. Digital Video Encoder

- (1) The DVE's power connection is through the output of the uninterruptible power supply (UPS).
- (2) Testing must be as per Manufacturer and in compliance with the Project Acceptance Test Plan.

#### D. Terminal Server – None

### 4. Power Requirements

#### A. ITS Cabinet – None

#### B. 10/100 Ethernet Switch

- (1) Provide, at no additional cost to MDOT, all software upgrades through final acceptance.
- (2) Furnish the TDS operator or user's manual and any applicable firmware.
- (3) Supply maximum power not to exceed 15 watts.
- (4) Testing - Testing must be in compliance with the Project Acceptance Test Plan.

### 5. Warranty

- A. A one year warranty for the fully integrated ITS Cabinet and its components is required from the date of final acceptance.
- B. The MFES must carry a manufacturer's standard warranty (parts, software and labor) of five years from the date of final acceptance.
- C. The DVE/s must be furnished with a manufacturer's standard warranty (parts, software and labor) of five years from the date of final acceptance.
- D. The TDS must carry a manufacturer's standard warranty (parts, software and labor) of five years from the date of final acceptance.

### **d. Measurement and Payment.**

1. Method of Measurement

- A. The work as described will be measured and paid for using the following contract items and is paid as each cabinet furnished, populated, burned-in, tested, field integrated and warranted.

2. **Contract Item (Pay Item)**

**Pay Item**

- A. Cabinet, ITS, Pole Mounted ..... Each  
B. Cabinet, ITS, Ground Mounted ..... Each

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**WIRELESS LINK, BACKHAUL**

DES: MM

1 of 12

03-14-2006

**a. Description.** This work consists of the furnishing, installation, integration and testing a Wireless Backhaul Link at locations designated on the Plans. In the plans, one half of a complete link is called out as "Wireless Link, Backhaul." This work is to be done in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

1. General

- A. The Integrator will furnish, install, integrate and test all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

2. Summary

- A. *Special Provision for Project Overview for ITS Work* is hereby incorporated into this special provision.
- B. *Special Provision for Basic Materials and Methods for ITS Work* is hereby incorporated into this special provision.
- C. *Special Provision for Communications Tower and Foundation* is hereby incorporated into this special provision.
- D. *Special Provision for Protect ITS Infrastructure* is hereby incorporated into this special provision.
- E. *Special Provision for Communications Tower Grounding* is hereby incorporated into this special provision.
- F. *Special Provision for Grounding and Bonding* is hereby incorporated into this special provision.
- G. The equipment used will be identical at each field location as noted on the Plans, and is to be completely interchangeable.
- H. The Integrator is to install and test, complete with all accessories the complete Wireless Backhaul Link which meets or exceeds all testing requirements as noted on Plans and in accordance with this Special Provision.
- I. The Integrator must conduct a terrain analysis and frequency analysis to determine the frequencies and path for this Backhaul Link.

3. Submittals

- A. The Integrator will provide complete equipment detail cut-sheets on all equipment to be provided under this Special Provision
- B. The Integrator will highlight each individual item on cut-sheet.
- C. The Integrator will include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.

- D. The Integrator will provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate and maintain all equipment proposed in the quotation. In addition, sources and list prices are required for equipment not manufactured by the Integrator.
- E. The Integrator will provide a shop drawing showing all devices and their connectivity.
- F. Two complete, comprehensive sets of instructions, block diagrams, and operating manuals will be furnished for each piece of equipment supplied; and will be provided in the form of printed copy and available on CD-ROM at no additional cost. The intent is for documentation at a level sufficient for maintenance to the lowest replaceable unit. Each instruction book will contain the following as a minimum:
  - (1) Complete block diagrams including information outlining method of operation, supply voltages, etc. for all equipment.
  - (2) Circuit diagrams showing internal wiring of all equipment and components
  - (3) Complete instructions covering operation, theory of operation, and maintenance of all equipment and accessories.
  - (4) Servicing manuals, instructions, and procedures will be of sufficient detail in order to perform detailed maintenance down to the sub-assembly level.
  - (5) Diagrams showing inter-equipment wiring and cabling including terminal block connections.
  - (6) Normal point-to-point operating voltages, current, and power levels for test and adjustment purposes.
  - (7) Detailed installation instructions, a detailed list of all replacement spare parts and Block and level diagrams.
  - (8) A list of recommended spare parts deemed necessary to maintain the equipment to the sub-assembly level.
- G. Two sets of as-built drawings for the whole system plus one set for each site will be supplied to the Department indicating the location of the equipment, exterior equipment wiring, cabling, block and level diagrams, and any other details that are either different or omitted from the instruction books supplied.
- H. All equipment furnished will fully meet all applicable Federal Communications Commission (FCC) rules and Electronic Industries Association (EIA) specifications.
- I. The Integrator will submit a proposal with his or her bid and a complete description of the operation of the proposed equipment. The proposal will include detailed specifications, photographs, panel layouts with labeled controls, model numbers, and, in general, show all phases of the proposed equipment. These specifications must be complete and cover in detail all requirements set forth herein.
- J. The Integrator will verify, in writing, final hardware and software installation configuration plans with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence installation.
- K. The Integrator will provide four copies of the Site Evaluation Report for this Special Provision.



- (1) As a part of the Site Evaluation Report for this Special Provision, the Integrator will provide the necessary frequency search and determine frequencies for each path intended as part of the link.
- (2) As a part of the Site Evaluation Report for this Special Provision, the Integrator will provide the terrain analysis.
- (3) The Site Evaluation Report will include other pertinent facts and the findings from the Pre-delivery Site Evaluation.
- (4) It is acknowledged that differences may exist in physical arrangements and mechanical construction of standard products of various manufacturers. However, the requirements as stated in the design criteria section describe a state-of-the-art microwave radio system concept as related to the operation, expansion, maintenance, and requirements of the State of Michigan and/or the Department.

**b. Materials.**

**1. General Requirements**

- A. The Wireless Backhaul Link will consist of a digital microwave radio product for 99.999% availability in all environmental conditions encountered in SE Michigan. This specification covers equipment operating in with a capacity of 155 Mbps (OC3 digital rate) minimum.
- B. Equipment
  - (1) Single Unit ground level, rack mounted transceiver
  - (2) Signal feed-lines or waveguide for one transceiver
  - (3) Preamplifiers, amplifiers for one transceiver
  - (4) Antenna system for one transceiver
  - (5) Dehydrators (if required) for one transceiver
  - (6) Mounting devices, racks, connections and all I/O data connections to an Ethernet Switch or Routing equipment
  - (7) Power supplies and power distribution
  - (8) Grounding and lightening protection systems
- C. The Integrator will determine the optimum height, gain and type of antenna based upon the installation site survey and the radio frequency to be used.
- D. Unless specifically excepted by the terms of these specifications, any parts or accessories ordinarily furnished or required to make the equipment herein specified a complete operating unit or system will be furnished by the Integrator whether directly mentioned in the specifications or not.
- E. The system will include a fully functional wireless Ethernet link with all standard industry interfaces for the signal payload, power connections, alarm I/O connections and any required data or service channel interfaces. This includes all other accessories such racks, fuse panels, DSX1 or DSX3 cross connect panels, fiber optic interconnect trays or panels, etc.
- F. All electrical equipments will operate on 120 volt 50/60 Hz electricity. The Integrator will provide appropriate DC conversion for any equipment requiring DC power.
- G. All outdoor enclosures will withstand hose-directed water, exposure to sand, dust, fungus, and salt atmosphere per MIL-E-5400T, Paragraphs 3.2.24.7, 3.2.24.8, and 3.2.24.9. All connections will be watertight.

- H. All field equipment installed will be operational in all weather conditions and will be able to withstand a wind load of 90 mph without permanent damage to mechanical and electrical equipment, and provide a stable video image.
  - I. The equipment used will be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
  - J. All field equipment will perform to stated specifications over a temperature range of -40° to 158° F and a humidity range of 5 percent to 95 percent relative non-condensing.
  - K. The Integrator will comply with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations.
  - L. The Integrator will provide and install all available software upgrades through final acceptance.
2. Requirements of Regulatory Agencies: The Integrator will comply with the latest edition of the following codes or standards:
- A. *Federal Communications Commission (FCC) Title 47 Parts 2, 15, and 101 as applicable*
  - B. *International Telecommunications Union - Telecommunications Standardization*
  - C. *Sector (ITU-T), formerly known as CCITT.*
  - D. *International Telecommunications Union Radio communication Sector (ITU-R), formerly known as CCIR*
  - E. *American National Standards Institute Standard C2 (ANSI).*
  - F. *Electronic Industries Association (EIA)*
  - G. *Telecommunications Industries Association (TIA)*

In case of conflicting requirements of standards, they apply in the sequence in which they are listed above. The complete apparatus will also comply with the applicable codes, laws, and regulations of all governmental agencies having jurisdiction. The following standards also apply:

- H. *National Electrical Manufacturers Association (NEMA).*
  - I. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
  - J. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
  - K. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
  - L. *Underwriters' Laboratories Standards 96 and 96A (UL).*
3. Functional Requirements
- A. The Wireless Backhaul Link will be implemented in a manner that will provide real-time traffic flow information.
  - B. Each device will have a unique address, which is changeable by switch settings. The unit will respond to the central command only if it is addressed.
  - C. Each transceiver pair will have a MTBF rate of at least 87,600 hours based upon failure data. In lieu of adequate field data for equipment recently placed into service, the Integrator will show a calculated MTBF from MIL-STD-217B stating what factors have been used.

- D. The Wireless Backhaul Link equipment will be able to be configured through Network Management Software (NMS) that is furnished by the Integrator. The NMS will be capable of providing error trapping and alert notification via phone, fax and/or email using standard SNMP management.
- E. Component Ratings: Each and every component part of the equipment will be operated within the manufacturer's continuous commercial-duty rating under any combination of operating conditions specified. Relays and switches will be hermetically sealed and rated for a minimum of 2 million operations.
- F. Overload Protection: Adequate fuses, circuit breakers, or other electronic devices will be included to protect the equipment from internal and external faults. In the event these fusing devices are employed in circuits exhibiting switching surges, a suitable time-delay element will be incorporated in the overload protection device to preclude false operation and yet protect the equipment from a sustained overload.
- G. Electrostatic Protection: The Integrator will provide electrostatic protection device, one per unit.
- H. Multiplex Equipment
  - (1) Multiplex equipment will mount in the same rack as the microwave radio equipment.
  - (2) Multiplex equipment will report equipment and transmission alarms and will provide an interface into the microwave radio alarm system so a single alarm interface is presented to the technician or person using the alarm system.
- I. Alarm and Control
  - (1) Each of the alarms will be available for display and metering locally as well as from any other terminal or repeater connected in the system to the same alarm and control system.
  - (2) The system will be capable of local and remote loop-back.
- J. DC Power Requirements
  - (1) All equipment supplied under this special provision will operate as specified with either a positive or negative ground over a voltage range from 90-130 VAC/60Hz and 42 to 56 VDC with a 200 mV (RMS), 60 to 180 Hz ripple.
  - (2) Each radio assembly will contribute no more than 30 mV RMS ripple to the DC bus, assuming a 400 amp-hour (AH) battery with the system bus rating of 100 A.
  - (3) Each radio rack assembly will be equipped with a DC distribution facility including power bus, ground bus, and fuse or circuit breaker panel. This DC distribution facility will provide main DC power for all the equipment installed in the rack. The DC distribution facility will be equipped with an alarm system to provide an alarm contact whenever a fuse or circuit breaker has opened.
  - (4) Radio equipment configured two or more to a rack will be individually fused. A power supply failure in one radio assembly will not affect any other path or hop. This includes the repair or replacement of the failed unit.
- K. Service Channel and Orderwire
  - (1) Each radio terminal or repeater assembly will be equipped with a minimum of two service channels capable of the following:
    - (a) One four-wire audio channel with a 600 ohm input.
    - (b) A data channel that interfaces at the RS-232 level
  - (2) The service channels will not decrease the traffic capacity of the system.

**L. Redundancy and Protection**

- (1) The microwave equipment will be designed for reliable operation through the use of redundant power supplies and other common equipment, but will not consist of more than one radio.
- (2) An alarm condition will be generated any time any equipment, with the exception of diversity receive, is operating in a protection mode.
- (3) The switching times, including maximum manual switching time, for all equipment will be stated. Maximum bit errors incurred and transmitter failure confirmation time will also be included. The maximum automatic switching time of the transmitter and transmitter multiplexer will be 50ms.
- (4) Equipment will provide both manual and automatic error free switching, receive only (and does not apply to 18 and 23GHz).
- (5) A complete or partial failure of the protection control or switching will not render the microwave link inoperable. Any failure of the protection control or switching equipment will generate a major alarm.
- (6) The equipment will be designed so that protection circuits and units not in service can be tested and repaired without affecting the online system operation.
- (7) The amplitude of the digital output signal will not change more than 2 dB as a result of a transmitter protection switching action.

**M. Digital Performance and Interface**

- (1) The Ethernet interface will comply with ANSI specifications and be not less than 155Mbps.

**4. RF PERFORMANCE MICROWAVE RADIO BAND**

A. Regulatory Compliance: All radio equipment supplied under this contract will meet the requirement of the approved Sub-Sections of Volume 47 of the Federal Code of Regulations.

**B. Frequency Range and Bandwidth**

- (1) The equipment supplied for this band will comply with the following requirements:

Capacity	RF Bandwidth in MHz
155Mbps	10700-11700

- (2) The frequency selected can be either licensed or unlicensed as long as all of the functional requirements of this specification can be met.
- (3) Bidders may provide other bandwidths as options. These will be fully compliant with the current FCC Part 101 technical requirements.
- (4) Feed-line Connection
  - (a) The antenna connection will be a CPR-90G. If an adapter is required to convert from the standard flange on the radio unit, it will be supplied and included in the unit price.
  - (b) The system will operate with an antenna system with a peak return loss of 23 dB or greater.
  - (c) A single feed-line connection point will be provided for all radio configurations except space diversity.
  - (d) The feed-line connection point will be at the top of the radio, clear of any obstructions. In cases where the radios are mounted two or more to a rack,

the feed-line connection may exit perpendicular to the back of the radio. However, in those cases, the Integrator will supply a rigid waveguide right-angle section to allow the connection to be made vertically.

- (e) The antenna coupling unit will have an option to accommodate the interconnection of additional analog or digital microwave radios to a common waveguide antenna feeder system.
- (5) RF Power Levels
  - (a) The equipment will have a minimum output High power level of +27dBm and Low Power level of less than or equal to +20dBm.
- (6) General Transmitter Specifications
  - (a) Frequency stability will be  $\pm 0.002$  percent or greater over the full operating range of the equipment. The frequency source will be synthesized.
- (7) Receiver Thresholds
  - (a) Receivers will have the following guaranteed receive thresholds as a maximum level to obtain a BER  $1 \times 10^{-6}$  of 1 in 10 in a non-protected configuration. Guaranteed capacity at minimum Received Signal Level (RSL) in dBm as listed below.
 

Capacity	Received Signal Level (RSL) in dBm
155 Mbps	-68
  - (b) Received threshold levels will be measured at the top of the flange and will include all branching losses.

(8) Interference Criteria

- (a) Threshold to interference (T/I) ratios for a like signal required are shown below for the following scenarios:

Frequency Offset	8 DS-1	16 DS-1	28 DS-1	84 DS-1
Co-Channel	33	33	33	34
Adjacent Channel	4	4	4	0
Semi-Adjacent Channel	30	30	30	31
Two Times Adjacent Channel	-28	-28	-28	-24

(9) General Receiver Specifications

- (a) The receiver frequency stability will be  $\pm 0.002$  percent or better over the operating range of the receiver. The frequency source will be synthesized and will contain automatic frequency control based on the input signal.
- (b) The receiver will have a maximum received signal limit of not less than -17.5dBm when at a 1 in 10 BER.
- (c) The dynamic range of the receiver will be a minimum of 48 dB.

(10) Dehydrators

- (a) Nodes, Hubs and Shelters
  - (i) Nodes and hubs currently incorporate automatic dehydrators. If required for operation, new dehydrators of similar type will be installed with the new digital microwave units. These automatic dehydrators will be of similar membrane type and be of suitable capacity and reduce waveguide humidity to a dew point of minus (-) 50 degrees centigrade. Normal service intervals will be not less than 2000 meter hours as determined by the integral hour meter.

- (ii) Dehydrator bleed down rate will be calculated and then measured against the observed system to check for leaks. No leaks are permitted.
    - (iii) All manufacturer recommendations must be observed.
    - (iv) Dehydrator alarms must be connected to the system alarm panel and be observable from the MITSC or BWBOC.
  - (b) Field Cabinets
    - (i) Field cabinets will be furnished by the System Integrator and installed by the Integrator.
    - (ii) Field cabinet sites that incorporate more than 4 waveguide feed-lines will use the automatic type dehydrator.
  - (11) Waveguide Antennas
    - (a) Camera lowering system pole mounted antenna size will not exceed four foot diameter except by approval of the Engineer. Consideration of smaller diameters will be given to FCC part 101 Category A approved antennas where signal loss budgets permit.
    - (b) Communication tower antenna size should be six foot diameter maximum unless approved by the Engineer. Consideration should be give to smaller sizes where signal loss budgets permit.
    - (c) Extreme care must be given to proper sealing of the waveguide pressure system. Testing of this system is mandatory for system approval. No observable pressure loss, as measured by a calibrated pressure gauge whose full scale pressure is 10 psi or less with 0.1 psi incremented scale, must occur in a pressure isolated waveguide system for a minimum period of 4 hours.
  - (12) Grounding of Feed-line and equipment
    - (a) All feed-lines will be grounded in accordance with the general specifications and in addition at the top, bottom (just above the turn into the shelter) and midpoint of the feed-line runs. The grounding kits must be connected to the buss bar, at that level, that is attached to the 4/0 copper vertical grounding wire.
    - (b) All equipment must be grounded for protection against lightning. This will be accomplished by attaching to the single point grounding system via the rack grounding wire. Individual bonds made with #12 copper wire from each piece of equipment to the rack grounding buss will be made. All rack equipment screws will be installed with star washers to facilitate the bond to the rack.
5. Mechanical Requirements
- A. Indoor (shelter) mounted equipment will be supplied in EIA standard, 7 foot, 19-inch or 23-inch racks. These racks will be equipped with standard 1-3/4" rack spacing and drilled and tapped for standard 12-24 NF screws. The rack will be included in the equipment pricing.
  - B. Cabinet mounted equipment and racks will meet the requirements of above except mounted in the 19 or 23" rack of the cabinet.
  - C. Equipment will be supplied that will allow for two complete RF and multiplex equipment assemblies to be mounted in the same rack space to allow for a complete hot-standby repeater or hot-standby terminal to be installed in a single rack space.

- D. All parts requiring service or maintenance must be accessible during normal operation. If covers, shields, or assemblies have to be removed for service, special tools other than a screwdriver and pliers will not be required. The fasteners holding items that are removed during service must be a captive type, designed for frequent use. All chassis will be designed to be physically and electrically detached conveniently from the rack for replacement or bench service. All inter-chassis and inter-rack cabling or wiring will have connectors designed for rapid connection and disconnection. All cable connectors will have cable clamps.
- E. All wiring and cabling will be supported such that the weight of the cable or pressure from bending is not transferred to the connector pins, wire-wrap point, or solder connection.
- F. Any piece of equipment or contact area on the equipment that is capable of inflicting an electrical shock or causing mechanical damage to a person working on the equipment will have protective covers and will have appropriate warning labels.
- G. The insulation on all wiring used in the equipment will not support combustion without an external source of ignition and will extinguish in less than 5 seconds after removal of the ignition source.
- H. Vibration: The radio, when mounted in an optional seismic style relay rack, will meet the requirements of TR-EOP-000063, section 4.5 for seismic and office vibrations. Also, the radio will be resistant to the effects of mechanical shock (microphonic induced transmission impairments) caused by normal maintenance actions such as unit replacements.

**c. Construction.**

- 1. Pre-delivery Site Evaluation
  - A. All aspects of the Pre-delivery Site Evaluation will be documented in the Site Evaluation Report.
  - B. The System Manager will arrange a meeting with representatives of the Integrator, Department and the Wireless Backhaul Link supplier within 30 days following the issuance of the notice to proceed to conduct an evaluation of all proposed Wireless Backhaul Link sites.
  - C. Each Wireless Network node site will be evaluated for optimal horizontal and vertical location, field of view, and potential adverse conditions. The Wireless Network equipment supplier will acknowledge concurrence with the final design of each Wireless Network node site. The Engineer will review the report and notify the Integrator in writing of any design modifications required for approval.
  - D. As a part of this evaluation, the Wireless Backhaul Link provider will:
    - (1) Provide a copy of the Site Evaluation Report.
    - (2) Complete a Terrain Analysis in accordance with FCC rules and regulations, and these Specifications. The Terrain Analysis will take into account specific localized obstructions and conditions (e.g., shadowing, multi-path interference) and include at a minimum, the following:
      - (a) Mapping module to include distance and bearing at each site.
      - (b) RF module to include adequacy of received signal levels.
      - (c) Shadowing module to include terrain or obstruction.
      - (d) Path module to include elevations of paths.

- E. The Wireless Backhaul Link provider will complete a Frequency Analysis in accordance with FCC Rules and Regulations, and this special provision. The Frequency Analysis will include an interference study related to the frequencies proposed. The findings of this study will be included in the Site Evaluation Report.
- F. The Integrator will provide equipment and labor to assemble and install all pole and tower equipment on the existing structures.

## 2. Wiring Requirements

- A. All wiring will meet the requirements of the National Electric Code. All wires will be cut to proper length before assembly. No wire will be doubled-back to take up slack. Wires will be neatly laced into cable with nylon lacing or plastic straps. Cables will be secured with clamps. Service loops will be provided at all connectors.
- B. All DC relays, solenoids, and holding coils will have diodes or other protective devices across the coils for transient suppression.
- C. The equipment will contain readily accessible, manually re-settable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.
- D. Circuit breakers or fuses will be provided and sized such that no wire, equipment, connector, PC board or assembly will be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.
- E. All external connections will be made by means of connectors. The connectors will be keyed to preclude improper hookups. All wires to and from the connectors will be color-coded and appropriately labeled. In order to assure compatibility and performance compliance, the cables unit will be assembled by the manufacturer. Connecting harnesses of appropriate length and terminated with matching connectors will be provided for interconnection with the Communications Network equipment.
- F. All pins and mating connectors will be plated to provide good electrical connection and resist corrosion. Connectors utilizing solder type connections will have each soldered connection covered by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.
- G. Coax braid will be neatly trimmed before crimping the connector to insure no possibility of contact between braid and inner connector. There will be no nicks in the center conductor. Crimps will be mechanically secure and made in such a way that no braid is left exposed or protruding from the connector. The center pin will be gold plated and will be installed with the tip of the center pin flush with the front edge of the connector.
- H. All modules and assemblies will be clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.
- I. All external connections will be made by means of connectors. The connectors will be keyed to preclude improper hookups. All wires to and from the connectors will be color-coded and/or appropriately marked. Pins and mating connectors will be plated with a minimum of twenty (20) microns of gold.
- J. Connecting harnesses of appropriate length and terminated with matching connectors will be provided and installed for interconnection with the communications equipment interface.



### 3. Power Requirements

- A. The Wireless Backhaul Link equipment will meet all of its specified requirements when the input power is 120 volts 60 Hz.
- B. The equipment will be powered from the output of the uninterruptible power supply (UPS).
- C. The maximum power required will not exceed 300 watts.
- D. Backup Power:
  - (1) The System Integrator will provide a dedicated control and communication cabinet, the Integrator will install as depicted within the Plans. Contained within the Cabinet will be an Uninterruptible Power Supply that will be capable of providing continuous operation for up to 90 minutes of normal operation without recharge.

### 4. Testing

- A. The Wireless Backhaul Link provider is responsible for furnishing all test equipment required to test the Wireless Backhaul Link in accordance with the parameters specified. Unless otherwise stated, the test equipment will not be considered part of the Wireless Backhaul Link. The Wireless Backhaul Link provider will furnish test equipment of accuracy better than the parameters to be tested.
- B. After pre-testing, the Wireless Backhaul Link will be formally tested in the presence of the Engineer.
- C. After the pre-test has been completed, after the Wireless Backhaul Link has been constructed, and 30 days prior to the date of acceptance, testing is expected to begin. The Wireless Backhaul Link will be tested per the Test Plan. The Integrator will verify in writing that the Wireless Backhaul Link meets all of the requirements of the specifications and complies with all appropriate standards listed in these special provisions.
- D. The Integrator will notify the Engineer in writing within seven (7) days after the pre-test has been completed and 30 days prior to the date of acceptance testing is expected to begin.
- E. At the Final Inspection, a factory-certified representative of the equipment manufacturer will perform the Acceptance Test. The representative will demonstrate that the Wireless Backhaul Link functions properly in every respect in the presence of the Department representative.
- F. The Wireless Backhaul Link will be tested to show a minimum of the following:
  - (1) Remote operation by the MITSC.
  - (2) Configuration, testing, and maintenance demonstration remotely from MITSC.
- G. The Wireless Backhaul Link testing will require the following minimum equipment list:
  - (1) Time Domain Reflectometer (TDR): Tectonix 1502C or equivalent
  - (2) RF Network Analyzer (FDR): Hewlett Packard 8711A or equivalent
  - (3) Precision Dummy Load: Hewlett Packard 908A or equivalent
  - (4) Precision Shorting Termination: Hewlett Packard 11511A or equivalent
  - (5) Microwave Power Meter with appropriate Power Heads: HP 438A & HP8487, HP8485 or equivalent.

- (6) Return Loss Bridge
  - (7) Pressure gauges, manifolds and associated waveguide testing equipment.
  - H. The Wireless Backhaul Link provider and/or the System Integrator will test and align the radio equipment and antenna feeders to ensure path performance in conformance with approved test plan.
  - I. The Wireless Backhaul Link provider will measure and record actual power at each transmitter and calculate ERP requirements.
  - J. The TDR test procedure will be used in an attempt to verify transmission line and connector integrity by looking for impedance imbalances along the length of the line as well as the transition to the top of the antenna.
  - K. The RF or FDR test procedure will be used to document the spectrum efficiency of the transmission line, transmission line terminated into 50 Ohms, transmission line open circuited, and the transmission line terminated into an antenna.
  - L. The antenna feeder Voltage Standing Wave Ratio (VSWR) will be verified over the operation frequency ranges and will be in compliance with the manufacturer's standards in the following areas:
    - (1) Verification of transmission line integrity after installation.
    - (2) Validation of transmission line length.
    - (3) Validation of transmission line insertion loss including top-mounted jumper.
    - (4) VSWR of transmission line and top-mounted jumper.
    - (5) VSWR of transmission line, top-mounted jumper, and antenna:
      - (a) Record receiver frequency bandwidth response.
      - (b) Record transmitter frequency bandwidth response.
    - (6) Selection process for antennas operating in the transmitter frequency band.
    - (7) Calculation of necessary transmitter power output for power budget ERP requirements.
  - 5. Upon completion of installation, all material will be free from defects, corrosion, scratches, or other such conditions as to present another-than-new appearance, and in accordance with the Plans and this Special Provision.
- d. Measurement and Payment.** The completed work will be paid for at the contract unit price for the following contract item (pay item):

<b>Contract Item (Pay Item)</b>	<b>Pay Unit</b>
Wireless Link, Backhaul.....	Each

The work for constructing the **Wireless Link, Backhaul** includes all labor, accessories, appurtenances and materials required for a fully functional data backhaul.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**WIRELESS LINK, POINT-TO-MULTIPOINT**

DES: MM

1 of 6

03-14-2006

**a. Description.** This work consists of the furnishing, installing, integrating and testing of a Point-to-Multipoint Wireless Network Segment (PTMP) at locations designated on the Plans. A PTMP is comprised of a Base Station Unit (BSU) and a Subscriber Unit (SU) and all cabling, antennas and the system appurtenances required to complete a functional link. A single BSU is capable of communicating with multiple SU's in a point-to-multipoint configuration as indicated on the Plans. This work must be performed in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

1. General

The Integrator must furnish, install, integrate and test all equipment and required components, including communications patch cords and jumpers, necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

2. Summary

- A. The payment process including partial payment will be governed by Section 109 of the *Michigan Department of Transportation Construction Manual*.
- B. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the Integrator as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- C. The Integrator must completely furnish and install, with all accessories, the required communications pathways.

3. Requirements of Regulatory Agencies

The compliance with the latest edition of the following codes or standards is required:

- A. *Institute of Electrical and Electronic Engineers (IEEE)*.
- B. *American Association of State Highway and Transportation Officials' (AASHTO)*.
- C. *National Television Systems Committee (NTSC)*.
- D. *National Transportation Communications for ITS Protocol (NTCIP)*.
- E. *American National Standards Institute Standard C2 (ANSI)*.
- F. *American Society of Testing and Materials' (ASTM)*.
- G. *American Society of Civil Engineers (ASCE)*.
- H. *American Institute of Steel Construction's (AISC)*.
- I. *Moving Picture Experts Group (MPEG)*.
- J. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*.
- K. *National Electrical Manufacturers Association (NEMA)*.
- L. *National Fire Protection Association (NFPA) 70 - National Electrical Code*.
- M. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code*.
- N. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177*.
- O. *Underwriters' Laboratories Standards 96 and 96A (UL)*.

## 4. General Requirements

- A. Furnish, assemble, fabricate and install materials that are new, corrosion resistant, and in accordance with the details depicted on the Plans.
- B. Install all the field equipment to be capable of operating in all weather conditions.
- C. Use identical and completely interchangeable equipment at each field location.
- D. Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- E. Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- F. All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

## 5. Functional Requirements

- A. The PTMP must be implemented in a manner that facilitates real-time traffic flow information.
- B. The PTMP and the Primary Backbone Communications Network must be fully interoperable. All data transmitted to the PTMP from the field devices is transmitted to MITSC by way of the Primary Backbone Communications Network. Any facilities or capabilities required to maintain connectivity throughout the network is included by the Integrator as a part of the work. These additional facilities may be necessitated by the following:
  - (1) Obstructions to wireless transmission (e.g., line of site obstruction, grazing obstruction).
  - (2) Frequency saturation.
  - (3) Interference.
  - (4) Law, ordinance, or other regulation.
- C. Minimum time between failure (MTBF) rate of at least 87,600 hours for both the SU and BSU based upon failure data is required. In lieu of adequate field data, the Integrator will submit a calculated MTBF utilizing MIL-STD-217B.
- D. Provide Network Management Software (password protected) allowing configuration of the PTMP and be capable of over-the-air software/firmware upgrades.
- E. A link reliability of 99.99% over the specified distance link for the PTMP is required.
- F. Provide PTMP connections that are configurable from a minimum of 1 Mbps to a maximum of 5 Mbps throughput per SU connected to a BSU without degradation of the reliability or required throughput of any other segment. **However, budgeted bitrate per link should be 3-Mbps.**
- G. Each PTMP BSU must be capable of providing the required number of non-overlapping channels to communicate with all SU's assigned to it.
- H. BSUs and SUs must be capable of being asymmetrically adjusted to enhance bandwidth.
- I. Provide PTMP software that enables configuration up and downstream link splits to accommodate high bandwidth video surveillance traffic with low latency up stream with lower bandwidth downstream to control the camera.
- J. PTMP must be capable of automatically compensating for temporary link degradation by adjusting the data rate.
- K. Dynamic and automatic selection of available channels while sustaining both highest bandwidth and most reliable link is required of the PTMP. The capability of locking in

- the BSU and SU channel manually (in either direction) and restrict each segment to specified channels is required.
- L. Mutual security authentication and provide support for DES or AES encryption and authentication via RADIUS is required of the PTMP
  - M. SU's must not be capable of communicating directly with each other.
  - N. Both the BSU and SU receive threshold and power output must be adjustable.
  - O. Power-over-Ethernet (PoE) provides the operating power source for all the BSUs and SUs.
  - P. The BSU must be capable of being configured to operate in a point-to-point mode.
  - Q. Less than 10 microsecond latency is required of the PTMP when using the Asynchronous Transfer Mode frame structure for CCTV channels.

**b. Materials.**

1. Equipment

- A. Provide and install all available software upgrades through final acceptance.
- B. PTMP Equipment
  - (1) Transmitter.
  - (2) Receiver.
  - (3) Antenna (as required).
  - (4) Cabling.
  - (5) Patch cords and jumpers.
  - (6) General Minimum Technical Requirements:
    - (a) Frequency Range to be determined by the Integrator
    - (b) Operation Mode: Full Duplex
    - (c) Network Connection Types: 100BASE-TX
    - (d) Intelligent Packet Filtering by Network Address, Protocol, or Packet Content
    - (e) SNMP Compliance: MIB I, MIB II
    - (f) Data Interface: IEEE 802.3, 802.d, 802.3u
    - (g) IEEE Configuration Standards: 802.1d Bridging Mode, 802.1q VLAN
    - (h) Remote Configuration: Wired or Wireless LAN Station Telnet, FTP, SNMP, or HTML Via Web Browser
    - (i) Packet Routing: Store and Forward Capable
    - (j) Error Checking: CRC32 Bit and Package Protocol Acknowledgment
    - (k) Network Topology: Point to Point, Point to Multi-Point
    - (l) LED Indicators: Equipment Status, Wired Network Activity, Wireless Network Activity
    - (m) Security Configurations: Authentication, IP/MAC Filtering.
- C. Submit for approval by the Engineer the optimum height, gain and type of antenna based upon the installation site survey and the radio frequency to be used.
- D. Each device must be uniquely addressable, which is changeable by switch settings.

**c. Construction.**

1. Pre-delivery Site Evaluation

- A. Provide to the Engineer the Site Evaluation Report that will document all aspects of the Pre-delivery Site Evaluation.
- B. A meeting with representatives of the Department and the PTMP supplier within 30 days following the issuance of the notice to proceed to conduct an evaluation of all

- proposed PTMP sites is required. No PTMP equipment can be released for shipment until the evaluation process has been completed.
- C. At each PTMP node site, the Integrator must evaluate the link for optimal horizontal and vertical location, field of view, and potential adverse conditions. Within seven (7) days following completion of the field investigations, provide to the Engineer a report describing the analysis made and identifying any and all recommended modifications. Concurrence of the design of each PTMP node site by the PTMP equipment provider is required. The Engineer must review the report and notify the Integrator in writing of any design modifications required for approval.
  - D. Provide all labor, tools, materials, equipment, and transportation required to conduct and complete this evaluation. The cost of the PTMP site evaluation will be included in the unit price of the PTMP pay item.
  - E. As a part of this evaluation:
    - (1) Provide five copies of the Site Evaluation Report.
    - (2) Complete a Terrain Analysis in accordance with FCC rules and regulations, and these Specifications. Taking into account specific localized obstructions and conditions (e.g., shadowing, multi-path interference) and include at a minimum within the terrain analysis the following:
      - (a) Mapping module to include distance and bearing at each site.
      - (b) RF module to include adequacy of received signal levels.
      - (c) Shadowing module to include terrain or obstruction.
      - (d) Path module to include elevations of paths.
  - F. VHF-UHF evaluation module to include:
    - (1) Link reliability analysis
    - (2) Signal levels
    - (3) Fade margins
  - G. Included in the Site Evaluation Report must be a Frequency Analysis in accordance with FCC Rules and Regulations and an interference study related to the frequency propose.
  - H. Provide equipment and labor to assemble and install all pole and tower equipment on the existing structures.
2. Documentation Required
- A. Provide a complete detail cut-sheet on all equipment under this Special Provision.
  - B. Highlight each individual item on cut-sheet.
  - C. Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
  - D. Present a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
  - E. Make available shop drawings showing all devices and their connectivity
  - F. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation
  - G. Provide four copies of the Site Evaluation Report for this Special Provision.
    - (1) As a part of the Site Evaluation Report for this Special Provision, provide the necessary frequency search and determine frequencies for each path intended as part of the segment.

- (2) As a part of the Site Evaluation Report for this Special Provision, provide the terrain analysis and predicted link reliability.
  - (3) Within the Site Evaluation Report, include other pertinent facts and the findings from the pre-delivery site evaluation.
3. Wiring Requirements
  - A. All wiring must meet the requirements of the National Electric Code. All wires must be cut to proper length before assembly with no wire doubled-back to take up slack. Cabling must be laced with nylon and plastic straps and secured with clamps. Provide service loops at all connection points.
  - B. All modules and assemblies must be clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.
4. Testing
  - A. At a minimum the PTMP test process demonstrates:
    - (1) Remote operation by the MITSC and BWBOC.
    - (2) Configuration, testing, and maintenance demonstration remotely from MITSC and BWBOC.
  - B. The Integrator is responsible for furnishing all test equipment required to test the PTMP. The furnishing of test equipment is an appurtenance of the PTMP.
  - C. The PTMP testing will require the following equipment:
    - (1) RF Network Analyzer
    - (2) Precision Dummy Load
    - (3) Precision Shorting Termination
  - D. Align the radio equipment and antenna feeders to ensure path performance in conformance with approved test plan.
  - E. Measure and record actual power at each transmitter and calculate ERP requirements.
  - F. The RF or FDR test procedure must be used to document the spectrum efficiency of the transmission line, transmission line terminated into 50 Ohms, transmission line open circuited, and the transmission line terminated into an antenna.
  - G. The antenna feeder Voltage Standing Wave Ratio (VSWR) must be verified over the operation frequency ranges and compliance with the manufacturer's standards in the following areas:
    - (1) Verification of transmission line integrity after installation.
    - (2) Validation of transmission line length.
    - (3) Validation of transmission line insertion loss including top-mounted jumper.
    - (4) VSWR of transmission line and top-mounted jumper.
    - (5) VSWR of transmission line, top-mounted jumper, and antenna:
      - (a) Record receiver frequency bandwidth response.
      - (b) Record transmitter frequency bandwidth response.
    - (6) Selection process for antennas operating in the transmitter frequency band.
    - (7) Calculation of necessary transmitter power output for power budget ERP requirements.
  - H. Testing, based on the Integrator supplied Test Plan, must begin 30 days prior to the date of acceptance Notification to the Engineer that the PTMP meets all of the requirements of the specifications and complies with all appropriate standards listed in these special provisions and is ready for final inspection.

- I. At the final inspection, a factory-certified representative of the equipment manufacturer is to perform the Acceptance Test and in doing so, demonstrate that the Wireless Network Segment functions properly in every respect in the presence of the Department representative.
- d. **Measurement and Payment.** The completed work will be paid for at the contract unit prices for the following contract items (pay items):

<b>Contract Item (Pay Item)</b>	<b>Pay Unit</b>
Wireless Link, PTMP, SU.....	Each
Wireless Link, PTMP, BSU.....	Each

The work for constructing the **Wireless Link, PTMP, SU** and **Wireless Link, PTMP, BSU** includes all labor, equipment, and materials to construct the item.



MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**WIRELESS LINK, CELLULAR**

DES: MM

1 of 4

03-14-2006

**a. Description.** This work consists of the furnishing, installation, integrating and testing of the device-level, environmentally hardened, cellular wireless modem and service. The wireless modem must be an outdoor/industrial-grade wireless modem that provides wire-speed Ethernet (10 mbps) connectivity from the remote Intelligent Transportation System (ITS) devices where this wireless modem is to be installed to the ITS network connection point at the BWBOC. The furnished Wireless Link, Cellular must be fully compatible and interoperable with the ITS network trunk Ethernet network interface.

1. General

The Integrator must furnish, install, integrate and test all equipment and components, including patch cords and jumpers, necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

2. Summary

- A. *Special Provision for Project Overview for ITS Work* is hereby incorporated into this special provision.
- B. *Special Provision for Basic Materials and Methods for ITS Work* is hereby incorporated into this special provision.
- C. *Special Provision for Communications Network* is hereby incorporated into this special provision.
- D. *Special Provision for Protect ITS Infrastructure* is hereby incorporated into this special provision.
- E. *Special Provision for Lightning Protection* is hereby incorporated into this special provision.
- F. *Special Provision for Grounding and Bonding* is hereby incorporated into this special provision.
- G. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the Integrator as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- H. The Integrator must furnish and install complete with all accessories the required communications pathways.

3. Requirements of Regulatory Agencies

The compliance with the latest edition of the following codes or standards is required:

- A. *National Television Systems Committee (NTSC)*
- B. *Moving Picture Experts Group (MPEG)*
- C. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*
- D. *National Electrical Manufacturers Association (NEMA).*
- E. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
- F. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
- G. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
- H. *Underwriters' Laboratories Standards 96 and 96A (UL).*
- I. *American National Standards Institute Standard C2 (ANSI).*

#### 4. General Requirements

- A. Furnish, assemble, fabricate or install materials that are new, corrosion resistant, and in accordance with the details shown on the Plans and in the Specifications. Sites requiring these links are I69MM1829 (DMS) and I69MM1834 (CCTV).
- B. Install all the field equipment to be capable of operating in all weather conditions.
- C. Use identical and completely interchangeable equipment at each field location.
- D. Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- E. Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- F. All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

#### 5. Functional Specifications

- A. Provide 99.9 percent error free operation; EIA-compatible Ethernet data communication by way of wireless CDMA 1x transmission; and a Category 5e copper shielded twisted pair (STP) transmission medium. An IEEE 802.3 compliant Ethernet connection for each remote ITS field device location is to be provided.
- B. Must be mountable inside a control cabinet, CCTV remote site cabinet or other field cabinet without the need for special environmental conditioning. Power supply must be internal to the wireless modem or supply Integrator must supply the appropriate power converter and cables and connections necessary to power the wireless modem. The wireless modem will have no moving parts, i.e. fans, and be completely of solid-state construction. The wireless modem must be resistant to all electromechanical interference (EMI). The wireless modem shall be installed so that it's fully accessible. The wireless modem will support full/half duplex Ethernet communication.
- C. Manufactured in compliance with the following IEEE networking standards for Ethernet communication:
  - (1) *IEEE-802.3, CSMA/CD – Ethernet: 10BASE-T Ethernet;*

#### 6. Performance Specifications

- A. Provide secure Ethernet communications over a wireless carrier's system from the connection point inside the BWBOC to the remote field device location.
- B. Provide a secure, Ethernet connection to a high speed cellular data network at the BWBOC.
- C. Provide an "always on" connection. No dialing in to the modem.
- D. The wireless link must support standardized security features.
- E. Provide a seamless Ethernet communications link from the BWBOC to the remote ITS device site.
- F. Provide a broadband, secure internet service from an ISP (Internet Service Provider) capable of providing communications to/from the cellular provider's network and to the ITS device. The ISP must have been providing like service in the area for 5 years.
- G. Internet Service and Wireless Carrier Service must be paid for by the Integrator for the duration of the construction contract beginning once the wireless modem is installed. Furthermore, the Integrator must provide and pay for Internet Service and Wireless Carrier Service for a period of one (1) year beginning the date of final acceptance. Service contracts must be fully transferable to the Department. The

- Integrator must notify the Department and begin the transfer process one month prior to end of the first year. Transferring of the service contracts must not affect the function or performance of the wireless link.
- H. Provide at the BWBOC feature-rich security features for the internet connection capable of NAT (Network Address Translation) and VPN (Virtual Private Network).
  - I. The wireless modem must have on-board embedded intelligence capable of maintaining a connection to the network that meets the requirements of this specification.
  - J. The wireless modem must support local and remote management.
  - K. Access via the network interface (over the air) by way of Telnet, File Transfer Protocol (FTP), or Simple Network Management Protocol (SNMP).
  - L. Fully upgradeable over the network/over the air.
  - M. DHCP server for local automatic IP assignment
  - N. Public and Private IP modes for local static IP assignment
  - O. Support SNMP v2 and v3
  - P. Domain name addressable
  - Q. Wireless data connection must meet or exceed CDMA 1x
  - R. Must adhere to CDMA 1x authentication schemes
  - S. Full duplex wireless transceiver
  - T. Minimum 50ohm TNC RF connector.
  - U. Field mountable external antenna capable of providing connectivity as described in this special provision.
  - V. Dual band support for both 800 MHz cellular and 1.9 GHz PCS bands
  - W. Support a maximum data rate (throughput) of 150 Kbps.

**b. Materials.** Wireless Link, Cellular Functional & Technical Specifications.

1. Ethernet and Management Copper Port Specifications
  - A. The wireless modem must be furnished with one (1) copper port. All copper ports are to be Type RJ-45. All 10Base-T ports are to meet the Category 5 specifications and be compliant with standard *EIA/TIA-568-A, Commercial Building Telecommunications Cabling Standard*, pin-outs.
  - B. All Category 5e cable shielded twisted pair (STP) network cables must be *EIA/TIA-568-A* compliant.
  - C. Access via a resident EIA-232 or Ethernet management port to access management features.
2. Mechanical Specifications
  - A. 115 volts power (plus or minus 10 percent) of alternating current (VAC) must be supplied to the wireless modem. If the device requires operating voltages of less than 115 VAC, the Integrator is required to supply the appropriate voltage converter. The maximum power consumption of the wireless modem must be 20 watts.
  - B. The wireless modem must contain diagnostic light emitting diodes (LEDs). These indicators must include link, TX, RX, speed (for copper 10/100 mbps ports only), and power LEDs.
3. Environmental Specifications
  - A. The equipment must meet all specifications during and after being subjected to an operating ambient temperature range of -30 to 60°C, and with a non-condensing humidity of 5 to 95 percent.
  - B. All system components in environmental housings must comply with the applicable

*NEMA TS 1 1998, Traffic Controller Assemblies with NTCIP Requirements*, unless otherwise stated within this special provision.

**c. Construction.**

**1. General Requirements**

- A. Furnish, install and integrate all available software upgrades through final acceptance.
- B. Furnish, install, and test all components as an appurtenance to the wireless link, including but not limited to wireless modem, antenna, patch cords, jumpers, adapters, Wireless Carrier Data service, Internet Service, Internet service modem, Internet service router and VPN appliance, as well as all required firmware and software necessary to provide a wireless link that meets the functional and performance requirements contained within this special provision.
- C. Complete initial ITS tests prior to implementation to ensure complete the specified operation.
- D. Coordinate with local utility companies to move, add, change, or delete services as required to facilitate a timely, cost effective, and efficient implementation.

**2. Documentation Required**

- A. Provide a complete detail cut-sheet on all equipment under this Special Provision.
- B. Highlight each individual item on cut-sheet.
- C. Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- D. Provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- E. Provide a shop drawing showing all devices and their connectivity.
- F. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

**3. Equipment**

- A. Testing must be as per Manufacturer and in compliance with the Project Acceptance Test Plan.

**4. Warranty**

The wireless modem shall carry a manufacturer's standard warranty (parts, software and labor) of five years from the date of final acceptance.

- d. Measurement and Payment.** The completed work will be paid for at the contract unit price for the following contract item (pay item):

Contract Item (Pay Item)	Pay Unit
Wireless Link, Cellular.....	Each

The work for constructing the **Wireless Link, Cellular** includes all labor, equipment, and materials to construct the item.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**VEHICLE INFRASTRUCTURE INTEGRATION TEST BED NETWORK**

DES: MM

1 of 6

03-14-2006

**a. Description.** This work consists of the furnishing, installing, integrating and testing of a Vehicle Infrastructure Integration (VII) Test Bed Network at locations designated on the Plans. A VII Test Bed Network is comprised of all Wireless Routers (WR), Access Points (AP), enclosures, all cabling, and the system appurtenances required to complete a functional network. An AP will be located at points along I-96 that will allow access to the backhaul network as indicated on the Plans. A WR will be the interface between the vehicle access wireless client card and the test bed network. This work must be performed in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

1. General

The Integrator must furnish, install, integrate and test all equipment and required components, including communications patch cords and jumpers, necessary to provide full and complete VII test bed functionality in all respects, without additional expense to the Department.

2. Summary

- A. The equipment used will be identical at each field location as noted on the Plans, and shall be completely interchangeable.
- B. A terrain and frequency analysis for network coverage area is required.

3. Requirements of Regulatory Agencies: The Integrator shall comply with the latest edition of the following codes or standards:

- A. *National Television Systems Committee (NTSC)*
- B. *Moving Picture Experts Group (MPEG)*
- C. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*
- D. *National Electrical Manufacturers Association (NEMA).*
- E. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
- F. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
- G. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
- H. *Underwriters' Laboratories Standards 96 and 96A (UL).*
- I. *Telecommunication Industry Association (TIA)*
- J. *National Public Safety Telecommunications Council (NPSTC)*
- K. *Federal Communications Commission (FCC)*

4. General Requirements

- A. Furnish, assemble, fabricate and install materials that are new, corrosion resistant, and in accordance with the details depicted on the Plans.
- B. Install all the field equipment to be capable of operating in all weather conditions.

- C. Use identical and completely interchangeable equipment at each field location.
- D. Use equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- E. Compliance with working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State and Local regulations are required of the Integrator.
- F. All equipment required for the configuration and testing of devices and subsystems contained within this project is to be supplied by the Integrator as an appurtenance to the equipment included within the project and at no additional cost to the MDOT.

5. Functional Requirements

- A. The VII Test Bed Network must be implemented in a manner that facilitates communication between test bed participants with wireless client cards in ad-hoc, peer-to-peer networks as well as between these participants and the AP's and WR's.
- B. The coverage footprint of the VII Test Bed Network shall be all lanes in all directions along I-96 from the I-96 and I-275 interchange westerly to Livingston County line.
- C. The VII Test Bed Network shall work seamlessly with the existing MDOT VII Test Bed and all of the Motorola equipment deployed along I-696 between Drake and M-5.
- D. The VII Test Bed Network and the Primary Backbone Communications Network must be fully interoperable. All data transmitted to the VII Test Bed Network from the clients is transmitted to MITSC by way of the Primary Backbone Communications Network. Any facilities or capabilities required to maintain connectivity throughout the network is included by the Integrator as a part of the work. These additional facilities may be necessitated by the following:
  - (1) Obstructions to wireless transmission (e.g., line of site obstruction, grazing obstruction).
  - (2) Frequency saturation.
  - (3) Interference.
  - (4) Law, ordinance, or other regulation.
- E. Test bed participants must be able to connect seamlessly throughout the coverage footprint without having to re-authenticate and re-associate with the network.
- F. Network Management Software (password protected) allowing configuration of the VII Test Bed Network and that must be capable of over-the-air software/firmware upgrades shall be provided.
- G. The VII Test Bed Network must employ a protocol for test bed participants moving at 100 miles per hour relative to a stationary object and manage hand-offs and routing without the need to re-authenticate.
- H. The VII Test Bed Network must manage, analyze and react to the quality of the RF links between network elements to ensure that no dropped connections are experienced.
- I. The VII Test Bed Network must implement security measures at the application, data link and device layers of the communication hierarchy to prevent unwanted intrusion into the network.
- J. The VII Test Bed Network must support data, voice, video and location services via a single integrated network.

- K. The VII Test Bed Network must provide the ability to prioritize transmissions based on the test bed participant's priority and the precedence indicated in the IP header which prioritizes traffic on a per hop basis.
- L. The Network Management Software must provide a means to manage the wireless infrastructure as well as the subscriber devices.
- M. The Network Management Software must be able to add and configure both infrastructure and subscriber devices, provide access to all configurable data in each device, support SNMP remote device configuration, provide an alarm browser that will alert the operator when trouble exists.
- N. The Network Management Software must also provide a DHCP access server to provide IP address management for the wireless broadband network and an authentication server that controls access to the wireless broadband network by checking the hardware address of a device against a list of authorized users and prevents unlisted devices from accessing the network.
- O. The Network Management Software must be able to retrieve performance statistics from the network elements.
- P. The VII Test Bed Network must be scaleable to any number of test bed participants and AP's or WR's.

#### 6. Submittals

- A. Provide a complete detail cut-sheet on all equipment under this Special Provision.
- B. Highlight each individual item on cut-sheet.
- C. Prior to a site evaluation, provide an equipment/parts list, schematic diagrams, equipment layouts, and device connection/protocol information.
- D. Present a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- E. Make available shop drawings showing all devices and their connectivity
- F. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.
- G. Provide four copies of the Site Evaluation Report for this Special Provision.
  - (1) As a part of the Site Evaluation Report for this Special Provision, provide the necessary frequency search and determine frequencies for each path intended as part of the segment.
  - (2) As a part of the Site Evaluation Report for this Special Provision, provide the terrain analysis and predicted link reliability.
  - (3) Provide a map showing the predicted coverage of the proposed VII Test Bed Network and the message success rate used as a basis of the coverage prediction.
  - (4) Within the Site Evaluation Report, include other pertinent facts and the findings from the pre-delivery site evaluation.

**b. Materials.****1. Equipment**

- A. Provide and install all available software upgrades through final acceptance.
- B. VII Test Bed Network Equipment
  - (1) WR
  - (2) AP
  - (3) Antennas (as required).
  - (4) Cabling.
  - (5) Patch cords and jumpers.
  - (6) Fiberglass enclosure with sunshield (as required).
- C. The AP's and WR's that are not co-located with other ITS equipment shall be enclosed in an all weather NEMA 4 fiberglass enclosure.
- D. The AP's and WR's shall operate over a temperature range of -35 to 55 degrees Celsius.
- E. The AP's and WR's shall have the capability to provide IP network connectivity to external devices via a software enabled 10/100 Ethernet interface with a RJ45 sealed Ethernet boot connector.
- F. The receive sensitivity for the AP's and WR shall be -85 dBm or better.
- G. The output power for the VII Test Bed Network shall be 24dBm or better.
- H. Submit for approval by the Engineer the optimum height, equipment orientation, gain and type of antenna based upon the installation site survey and the radio frequency to be used.
- I. Each device is to be uniquely addressable, which is changeable by switch settings.

**c. Construction.****1. Pre-delivery Site Evaluation**

- A. Provide to the Engineer the Site Evaluation Report that will document all aspects of the Pre-delivery Site Evaluation.
- B. A meeting with representatives of the Department and the VII Test Bed Network supplier within 30 days following the issuance of the notice to proceed to conduct an evaluation of all proposed VII Test Bed Network sites is required. No VII Test Bed Network equipment can be released for shipment until the evaluation process has been completed.
- C. At each VII Test Bed Network site, the Integrator will evaluate for optimal horizontal and vertical location, field of view, and potential adverse conditions. Within seven (7) days following completion of the field investigations, provide to the Engineer a report describing the analysis made and identifying any and all recommended modifications. Concurrence of the design of each VII Test Bed Network site by the VII Test Bed Network equipment provider is required. The Engineer will review the report and notify the Integrator in writing of any design modifications required for approval.
- D. Provide all labor, tools, materials, equipment, and transportation required to conduct and complete this evaluation. The cost of the VII Test Bed Network site evaluation will be included in the unit price of all the VII Test Bed Network equipment.
- E. As a part of this evaluation:
  - (1) Provide five copies of the Site Evaluation Report.
  - (2) Complete a Terrain Analysis in accordance with FCC rules and regulations, and these Specifications. Taking into account specific localized obstructions and



conditions (e.g., shadowing, multi-path interference) and include at a minimum within the terrain analysis the following:

- (a) Mapping module to include distance and bearing at each site.
- (b) RF module to include adequacy of received signal levels.
- (c) Shadowing module to include terrain or obstruction.
- (d) Path module to include elevations of paths.

F. VHF-UHF evaluation module to include:

- (1) Link reliability analysis
- (2) Signal levels
- (3) Fade margins

G. Included in the Site Evaluation Report must be a Frequency Analysis in accordance with FCC Rules and Regulations and an interference study related to the frequency propose.

H. Provide equipment and labor to assemble and install all pole and tower equipment on any sites that are to be installed on existing structures.

2. Wiring Requirements

A. All wiring must meet the requirements of the National Electric Code. All wires are to be cut to proper length before assembly with no wire doubled-back to take up slack. Cabling is to be laced with nylon and plastic straps and secured with clamps. Provide service loops at all connection points.

B. All modules and assemblies must be clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.

3. Testing

A. At a minimum the VII Test Bed Network test process demonstrates:

- (1) Remote operation by the MITSC.
- (2) Configuration, testing, and maintenance demonstration remotely from MITSC.
- (3) File transfer through client to client networking.
- (4) File transfer and IP network connectivity between client and the backhaul network.

B. The Integrator is responsible for furnishing all test equipment required to test the VII Test Bed Network. The furnishing of test equipment is an appurtenance of the VII Test Bed Network.

C. Align the radio equipment and antenna feeders to ensure path performance in conformance with approved test plan.

D. Testing, based on the Integrator supplied Test Plan, is to begin 30 days prior to the date of acceptance Notification to the Engineer that the VII Test Bed Network meets all of the requirements of the specifications and complies with all appropriate standards listed in these special provisions and is ready for final inspection.

E. At the final inspection, a factory-certified representative of the equipment manufacturer is to perform the Acceptance Test and in doing so, demonstrate that the VII Test Bed Network functions properly in every respect in the presence of the Department representative.

- d. **Measurement and Payment.** The completed work will be paid for at the contract unit prices for the following contract items (pay items):

<b>Contract Item (Pay Item)</b>	<b>Pay Unit</b>
VII Test Bed Access Point.....	Each
VII Test Bed Wireless Router.....	Each
VII Test Bed Device Enclosure, Fiberglass with Sunshield.....	Each

The work for constructing the **VII Test Bed Access Point, VII Test Bed Wireless Router** and **VII Test Bed Device Enclosure, Fiberglass with Sunshield** includes all labor, other miscellaneous equipment such as antennas, inter-equipment cabling, above ground conduits, jumper cords, mounting appurtenances to construct the item.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**GROUNDING AND BONDING**

DES: MM

1 of 3

03-15-2006

**a. Description.** This work consists of furnishing and installing Grounding and Bonding at locations designated on the Plans. This work must be done in accordance with the 2003 Standard Specifications for Construction, except as modified herein.

1. General

The Integrator must furnish, install, test and integrate all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.

2. Summary

- A. All equipment required for the testing of devices and subsystems contained within this project must be supplied by the Integrator as an appurtenance to the electronic equipment included within the project and at no additional cost to the MDOT.
- B. The Integrator must furnish and install complete with all accessories the required communications pathways.

3. Requirements of Regulatory Agencies

The compliance with the latest edition of the following codes or standards is required:

- A. *National Television Systems Committee (NTSC)*
- B. *Moving Picture Experts Group (MPEG)*
- C. *Institute of Electrical and Electronic Engineers (IEEE) 802.3*
- D. *National Electrical Manufacturers Association (NEMA).*
- E. *National Fire Protection Association (NFPA) 70 - National Electrical Code.*
- F. *National Fire Protection Association (NFPA) 780 - Lightning Protection Code.*
- G. *Lightning Protection Institute (L.P.I.) Standards 175, 176, and 177.*
- H. *Underwriters' Laboratories Standards 96 and 96A (UL).*
- I. *American National Standards Institute Standard C2 (ANSI).*

4. Installer's Qualifications

The installation of grounding and bonding must be performed by a certified Electrician.

**b. Materials.**

1. General Requirements

- A. Complete initial ITS tests prior to implementation to ensure complete the specified operation.
- B. Coordinate with local utility companies to move, add, change, or delete services as required to facilitate a timely, cost effective, and efficient implementation.

2. Components

- A. Provide and install insulated wire and cables as indicated within the Plans and bare copper wire and cables, sized per NEC.

- B. Underground connections must be exothermically welded type and must be UL listed for that particular application and pre-approved by the Engineer.
- C. Above Ground Connections: Mechanical pressure type and heavy duty bolted clamps, UL listed.
- D. Grounding Electrodes (Driven Rods): Provide copper-clad steel with high strength steel core and welded copper outer sheath, 3/4 inch diameter by 10 feet.
- E. Ground Bus: Provide copper bar stock, 1/4 inch by 3 inch by length as shown on Plans, 12 inch minimum length, wall mounted, complete with stand off insulators and steel wall mounting brackets at 24 inch minimum spacing, or 9 inch spacing for minimum length bar. Suitable holes for NEMA 2 hole connectors and stand off insulators must be field drilled.
- F. Grounding Grids: Provide a separate grounding grid for each pad mounted primary switchgear enclosure, pad mounted transformer and service entrance location. Each grounding consisting of at least three (3) driven rods separated by at least 20 feet and interconnected with #4/0 bare stranded copper cable, or as indicated on Plans.

**c. Construction.**

**1. Documentation Required**

- A. Provide a complete detail cut-sheet on all equipment under this Special Provision.
- B. Highlight each individual item on cut-sheet.
- C. Include equipment/parts list, schematic diagrams, equipment rack layouts, and device connection/protocol information.
- D. Provide a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test and maintain all equipment proposed on this project.
- E. Provide a shop drawing showing all devices and their connectivity.
- F. Verify, in writing, final hardware and software installation configuration plans including wiring circuit schematics with the Engineer prior to any field installation. Ten (10) business days will be required to review detailed plans prior to authorization to commence final installation.

**2. Installation**

- A. All metallic items such as cabinets, pedestals, mast-arms, span cables, poles and metal conduit must be bonded and grounded to form a continuous grounding system.
- B. Provide grounding grids as noted on Plans.
- C. Ground to ground rod impedance must be 5 ohms.
- D. Provide green insulated conductors, sized to correlate with over-current devices protecting the circuit. They must be attached to grounding bushings on conduit, to lugs on boxes and other enclosures. Connection to neutral must only occur at service neutral bar.
- E. Bonding wire must be installed in non-metallic and flexible conduit connected at source end to panel-board equipment ground bar and at load end to enclosure.
- F. All busway enclosures must be grounded to main distribution panel ground with separate green insulated ground conductors.
- G. Post Light Grounding requires ground conductor with green insulation to lightning standards. Using corrosion-resistant ground stud or ground clamp to feed-in point ground.
- H. Install ground wires in all raceways.

- I. Bond grounding conductors to lightning protection system down conductors or grounding conductors per NFPA 78 are required. Bond communications system directly to lightning protection system at closest point to service grounding electrode per NEC are required.
  - J. Ground all manholes, hand-holes and junction boxes.
3. Communications Network Installation
- A. Provide one (1) 12 inch long wall mounted ground bus, suitably located at each communications utility service entry point, inter-building copper circuit entry point, and the main distribution frame (MITSC) equipment room.
  - B. Provide one (1) #2/0 stranded copper conductor in conduit from each communication and utility service entry point to main electrical service grounding point.
  - C. Provide one (1) #6 stranded copper conductor in conduit from each ground bus to nearest approved grounding electrode.
4. Testing
- A. Measure ground grid resistance using 3-point method per IEEE 81 with earth ground test meter. Install additional ground rods and conductors as required and re-measure until resistance to ground is equal to, or less than:
    - (1) Manholes, Hand-holes, Junction Boxes, Fences, and Pad Mounted Equipment: 5 Ohms.
    - (2) Electronic Equipment and Raised Floor Systems: 1 Ohm.
  - B. The Integrator is responsible for furnishing all test equipment required to test the copper cabling in accordance with the parameters specified.

**d. Measurement and Payment.** The completed work as described is included in other pay items where attached by reference in other Special Provisions, and therefore not paid for separately. "Grounding and Bonding" consists of the furnishing, installing and testing all the necessary material and equipment to complete the installations as shown on the Plans.

**NOTICE TO BIDDERS**

**REQUIREMENTS FOR  
INTELLIGENT TRANSPORTATION SYSTEMS**

Potential bidders are cautioned to pay particular attention to the following requirements in the MDOT 2003 *Standard Specifications for Construction*:

1. **Section 819.03.8 Clearing:** After the conduit runs are installed, pull a mandrel 12 inches long (shorter in conduit runs with bends) and ½ inch smaller in diameter than the conduit. Attach a suitable swab or cleaning device designed to clear the conduit of small pebbles, etc. to the mandrel. Notify the Engineer before doing this phase of work so that the work may be witnessed.
2. **Section 819.03.12 Record Drawings:** Within five days after completion of the conduit work or any portion where a working cable is installed. Furnish a record drawing to the Engineer. Show the length of the duct lines as constructed and show all departures from the original plans. Measure the lengths from the inside walls of the handholes and the center of post foundations and cable poles.
3. **As Built Drawings:** As Built drawings for all MITS infrastructure installed shall be provided no later than 90 days after completion of construction. As Built drawings may be furnished on the 24" by 36" plan sheets or on the 11" by 17" half sized drawings. Show the length of the duct lines as constructed and show all departures from the original plans. Measure lengths from the inside walls of the handholes and the center of post foundations and cable poles.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**MAINTAINING TRAFFIC**

DES:MM

1 of 7

03-29-06

**GENERAL**

This work shall consist of the construction of ITS facilities along I-94 (from 500 feet west of Morang Drive in Detroit to the Blue Water Bridge in Port Huron), I-69 (from Braidwood Road to I-94), and I-96 (from the Livingston/Oakland County Line to I-275). The project includes wireless communications equipment and other devices within MDOT right-of-way.

Traffic shall be maintained by the integrator throughout the project in accordance with Sections 103.05, 103.06 and 812 of the Michigan Department of Transportation's 2003 Standard Specifications for Construction, and any supplemental specifications in this proposal, and as specified herein.

The Integrator shall notify the Engineer a minimum of five (5) business days prior to the implementation of any ramp closures, lane closures, and shoulder closures.

The Integrator shall coordinate his operations with Integrators performing work on other projects within or adjacent to the Construction Influence Area (CIA) as described below. These projects include, but are not limited to:

CS 63021	JN 49947A	Painting of 5 Bridges in the I-96/I-696/I-275/M-5 Interchange
CS 63022	JN 76201A	Signing Replacement and Upgrades along I-96 and M-5
CS 63021	JN 72614A/ JN 84065A	Bridge Replacement of Grand River Ave over the Rogue River and CPM Mill/Resurface of Grand River Ave from Halsted/Freedom to Purdue
CS 63081/ CS 63101	JN 45715A/ JN 54301A/ JN 54303A	New Interchange Construction at I-696 and Franklin and M-10 Reconstruction from Beck (Southfield) to Lahser
CS 63022	JN 83723A	CPM Mill/Resurface of M-5 from Haggerty to Grand River
CS 77111	JN 45758A	Concrete Overlay, Bridge Replacement at I-94 and Gratiot

MDOT maintenance crews and/or Contract Maintenance Agencies may perform maintenance work within or adjacent to the Construction Influence Area (CIA). The Maintenance Division of MDOT and/or Contract Maintenance Agency will coordinate their operations with the Resident Engineer to minimize the interference to the Integrator. No additional payment will be made to the Integrator for the joint use of traffic control items.

The Integrator shall contact the local jurisdiction (City, Township, and/or County), as well as MDOT and MITSC, and provide Integrator's name, daytime and emergency phone numbers, permit number under which work is being performed, and location being worked on, a minimum of five (5) business days prior to beginning any work.

### **CONSTRUCTION INFLUENCE AREA (CIA)**

The CIA shall include the right-of-way of the following roadways, within the approximate limits described below:

I-94 from approximately one-half (1/2) mile west of Morang Drive to the Blue Water Bridge.

I-69 from approximately one-half (1/2) mile west of Braidwood Road to I-94.

I-96 from approximately one-half (1/2) mile west of the Livingston/Oakland County Line to I-275.

The CIA shall include all freeway ramps and service drives along I-94, I-69, and I-96 adjacent to the work zone.

The CIA shall include the rights-of-way of any intersecting roads adjacent to the work zone for a distance of approximately 1,000 feet in advance of I-94, I-69, and I-96.

### **TRAFFIC RESTRICTIONS - GENERAL**

No work shall be performed or lane closures shall be allowed during the following holiday periods:

Easter (from Friday 04/14/06 at 12:00 PM to Monday 04/17/06 at normal starting time)

Memorial Day (from Friday 05/26/06 at 3:00 PM to Tuesday 05/30/06 at normal starting time)

July 4<sup>th</sup> (from Friday 06/30/06 at 3:00 PM to Wednesday 07/05/06 at normal starting time)

Labor Day (from Friday 09/01/06 at 3:00 PM to Tuesday 09/05/06 at normal starting time)

Thanksgiving (from Wednesday 11/22/06 at 3:00 PM to Monday 11/27/06 at normal starting time)

Also, no work shall be performed during Detroit Lions home football games, or during any other special events as defined by the Engineer.

On I-96, no work shall be performed (except for shoulder closures) during MSU home games on the following dates: 09/09/06, 09/23/06, 09/30/06, 10/14/06, 11/04/06, and 11/11/06.

All lanes of traffic in each direction shall be maintained at all times on I-94, I-69, and I-96, except as noted in TRAFFIC RESTRICTIONS – HOURLY.



No lane closures shall be allowed where the work can be accomplished with a shoulder closure, as determined by the Engineer.

No more than one (1) lane and/or shoulder closure in each direction of traffic shall be permitted simultaneously on I-94, I-69, and I-96, except as directed by the Engineer.

Consecutive lane closures and shoulder closures shall be at least two (2) miles apart.

Lane closures and shoulder closures shall not exceed one (1) mile in length.

Lane closures and shoulder closures will not be allowed on both sides of the roadway at the same time and location.

During all work, the speed limit will be dropped to 45 mph in accordance with the appropriate typical.

The Integrator shall notify the Engineer at least 24 hours in advance of erection or removal of overlays on existing signs.

Access for construction vehicles between the travel lanes and work areas will be restricted to specific locations. The number of access points and their locations will require the prior approval of the Engineer.

Once work is initiated that includes any lane restrictions, that work shall be continuous until completed. A lack of work activity for more than three (3) hours will require the removal and replacement of lane restrictions at the Integrator's expense.

The Integrator shall acquire all roadwork permits required by City or Local Government agencies that have jurisdiction over the roadway impacted by this construction.

## **TRAFFIC RESTRICTIONS - HOURLY**

### **Macomb County:**

On I-94, shoulder closures are allowed at any time. Eastbound single lane closures are allowed from 9:00 AM to 2:30 PM Monday to Friday, and from 9:00 PM Friday to 5:00 AM the following Monday when actively working. Westbound single lane closures are allowed from 9:30 AM to 8:00 PM Monday to Friday, and from 9:00 PM Friday to 5:00 AM the following Monday when actively working.

### **St. Clair County:**

On I-94, shoulder closures are allowed at any time. Single lane closures are allowed from 8:30 AM to 5:00 PM Monday to Saturday, or as directed by the Engineer. On I-69, shoulder closures are allowed at any time. Single lane closures are allowed from 8:30 AM to 5:00 PM Monday to Saturday, or as directed by the Engineer.

**Oakland County:**

I-96, no hauling of heavy items (such as poles, concrete trucks, etc.) nor construction zone set-up will be allowed from 6:00 AM to 9:00 AM and 3:00 PM to 7:00 PM Monday to Friday. Shoulder closures are allowed at any time, if the necessary temporary traffic control devices are already in place. The right lane may be closed from 9:00 AM to 3:00 PM Monday to Friday, from 9:00 PM to 5:00 AM Monday to Thursday, and all day Saturday and Sunday.

**TRAFFIC CONTROL DEVICES**

All traffic control devices and their usage shall conform to revised Part 6 of the Michigan Manual of Uniform Traffic Control Devices (MMUTCD), 2005 edition, and as specified herein.

During non-working periods, any work site with uncompleted work shall have advance construction signs (W21-4 - "ROAD WORK AHEAD") and Plastic Drums, High Intensity, Lighted, at specific locations, as directed by the Engineer, at no additional cost to the Department.

Access to all business and residential drives shall be maintained during construction.

Recommended taper lengths, buffer lengths, and distances between construction zone signs shall be as shown on attached Typical Plan M000e.

Advance lead-in signing on I-94, I-69, and I-96, shall be as shown on attached Typical Plan M001fe.

Signing for a shoulder closure shall be as shown on attached Typical Plan M898e.

Two (2) additional W21-4 ("ROAD WORK AHEAD") signs are included in the quantities, to be placed on ramps or intersecting roads in advance of construction areas as directed by the Engineer. In addition, two (2) each "ON I-94", "ON I-69", and "ON I-96" plaques are included in the quantities, to be placed on separate supports adjacent to the W21-4 signs.

Two (2) additional R5-18 ("TRAFFIC FINES DOUBLED IN WORK ZONES") signs are included in the quantities to be placed at locations designated by the Engineer.

Two (2) additional R5-18b ("INJURE / KILL A WORKER \$ 7500 + 15 YEARS) signs are included in the quantities to be placed at locations designated by the Engineer.

G20-2 ("END ROAD WORK") signs shall be placed at the end of the construction zone on all affected roads.

All diamond-shaped warning signs shall be 48" x 48" mounted at a 7-foot minimum bottom height.

All diamond-shaped warning signs shall be NCHRP 350 compliant.

Temporary signs on portable supports that straddle median barrier, not required for a particular work operation, shall be removed or completely covered.

Payment to cover temporary signs is considered to be included in the cost of the temporary signs.

Temporary signs on portable supports that do not straddle median barrier not required for a particular work operation, shall be removed or laid down with the legs off.

Each temporary sign support shall be held in place by two (2) 35-pound sandbags.

Distances shown between construction warning, regulatory and guide signs shown on the typicals may require field adjustment, as directed by the Engineer.

All temporary signs shall be faced with prismatic retroreflective sheeting.

Channelizing devices required shall be Plastic Drums, High Intensity, Lighted.

Fifty (50) additional Plastic Drums, High Intensity, Lighted, Furn and Oper are included in the quantities to be used at the discretion of the Engineer.

Truck-Mounted Impact Attenuators shall be required during lane closures and shoulder closures on freeways. Placement of attenuators shall be as directed by the Engineer.

## **MEASUREMENT AND PAYMENT**

The estimate of quantities for maintaining traffic on this project is based on the suggested sequence of operations. Payment for these devices shall be in accordance with Section 812 of the Michigan Department of Transportation's 2003 Standard Specifications for Construction, unless otherwise specified.

Payment is based on signing and related traffic control devices for:

two (2) shoulder closures

Payment for temporary signs will be made on the maximum square footage of dissimilar sign legends required during the project.

Any additional signing or maintaining traffic devices required to expedite the construction shall be at the Integrator's expense.

**ESTIMATE OF TRAFFIC CONTROL DEVICES**

<b><u>PAY ITEM</u></b>	<b><u>QTY.</u></b>	<b><u>UNIT</u></b>
Lighted Arrow, Type C, Furn	2	Ea
Lighted Arrow, Type C, Oper	2	Ea
Lighted Arrow, Type C, Standby	1	Ea
Minor Traf Devices	1	LS
Plastic Drum, High Intensity, Lighted, Furn	150	Ea
Plastic Drum, High Intensity, Lighted, Oper	150	Ea
Sign Cover	10	Ea
Sign, Type B, Temp, Prismatic, Furn	980	Sft
Sign, Type B, Temp, Prismatic, Oper	980	Sft
Truck Mtd Attenuator, Furn	2	Ea
Truck Mtd Attenuator, Oper	2	Ea

**ESTIMATE OF TEMPORARY SIGN QUANTITIES SIGN MESSAGE**

**QTY. in x in Sq. Footage Sign, Type B, Temporary, Prismatic Retroreflective Sheeting:**

W20-3a	SHOULDER CLOSED AHEAD	2	48 X 48	32
W21-4	ROAD WORK AHEAD	6	48 X 48	96
R2-1	SPEED LIMIT XX	20	48 X 60	400
R2-5a	REDUCED SPEED AHEAD	4	48 X 60	80
R5-18	TRAFFIC FINES DOUBLED IN WORK ZONES	6	48 X 60	120
R5-18b	INJURE / KILL A WORKER \$7500 + 15 YEARS	6	48 X 60	120
R5-18c	WORK ZONE BEGINS	4	48 X 48	64
G20-2	END ROAD WORK	4	48 X 24	32
Plaque	ON I-94	2	48 X 18	12
Plaque	ON I-69	2	48 X 18	12
Plaque	ON I-96	2	48 X 18	12
<b>Total, Sign Type B, Temp, Prismatic: Sft</b>				<b>980</b>

# MINIMUM MERGING TAPER LENGTH "L" (FEET)

OFFSET FEET	POSTED SPEED LIMIT, MPH (PRIOR TO WORK AREA)									
	25	30	35	40	45	50	55	60	65	70
1	10	15	20	27	45	50	55	60	65	70
2	21	30	41	53	90	100	110	120	130	140
3	31	45	61	80	135	150	165	180	195	210
4	42	60	82	107	180	200	220	240	260	280
5	52	75	102	133	225	250	275	300	325	350
6	63	90	123	160	270	300	330	360	390	420
7	73	105	143	187	315	350	385	420	455	490
8	83	120	163	213	360	400	440	480	520	560
9	94	135	184	240	405	450	495	540	585	630
10	104	150	204	267	450	500	550	600	650	700
11	115	165	225	293	495	550	605	660	715	770
12	125	180	245	320	540	600	660	720	780	840
13	135	195	266	347	585	650	715	780	845	910
14	146	210	286	374	630	700	770	840	910	980
15	157	225	307	400	675	750	825	900	975	1050

TAPER LENGTH "L" IN FEET

THE FORMULAS FOR THE MINIMUM LENGTH OF A MERGING TAPER IN DERIVING THE "L" VALUES SHOWN IN THE ABOVE TABLES ARE AS FOLLOWS:

"L" =  $\frac{W \times S^2}{60}$  WHERE POSTED SPEED PRIOR TO THE WORK AREA IS 40 MPH OR LESS

"L" = S x W WHERE POSTED SPEED PRIOR TO THE WORK AREA IS 45 MPH OR GREATER

L = MINIMUM LENGTH OF MERGING TAPER

S = POSTED SPEED LIMIT IN MPH  
PRIOR TO WORK AREA

W = WIDTH OF OFFSET

## TYPES OF TAPERS

### UPSTREAM TAPERS

MERGING TAPER

SHIFTING TAPER

SHOULDER TAPER

TWO-WAY TRAFFIC TAPER

### DOWNSTREAM TAPERS

(USE IS OPTIONAL)

## TAPER LENGTH

L - MINIMUM

1/2 L - MINIMUM

1/3 L - MINIMUM

100' - MAXIMUM

100' - MINIMUM

(PER LANE)



TRAFFIC AND SAFETY  
MAINTAINING TRAFFIC  
TYPICAL

TABLES FOR "L", "D" AND "B" VALUES

DRAWN BY: DFK

CHECKED BY: BMM

MARCH 2000

PLAN DATE:

M000e

SHEET

1 OF 2

FILE: K:\DGN\TSR\STDS\ENGLISH\MNTTRF\M000e.dgn

REV. Nov. 24, 2003

## DISTANCE BETWEEN TRAFFIC CONTROL DEVICES "D"


"D" DISTANCES	POSTED SPEED LIMIT, MPH (PRIOR TO WORK AREA)									
	25	30	35	40	45	50	55	60	65	70
D (FEET)	250	300	350	400	450	500	550	600	650	700

## GUIDELINES FOR LENGTH OF LONGITUDINAL BUFFER SPACE<sup>1</sup> "B"

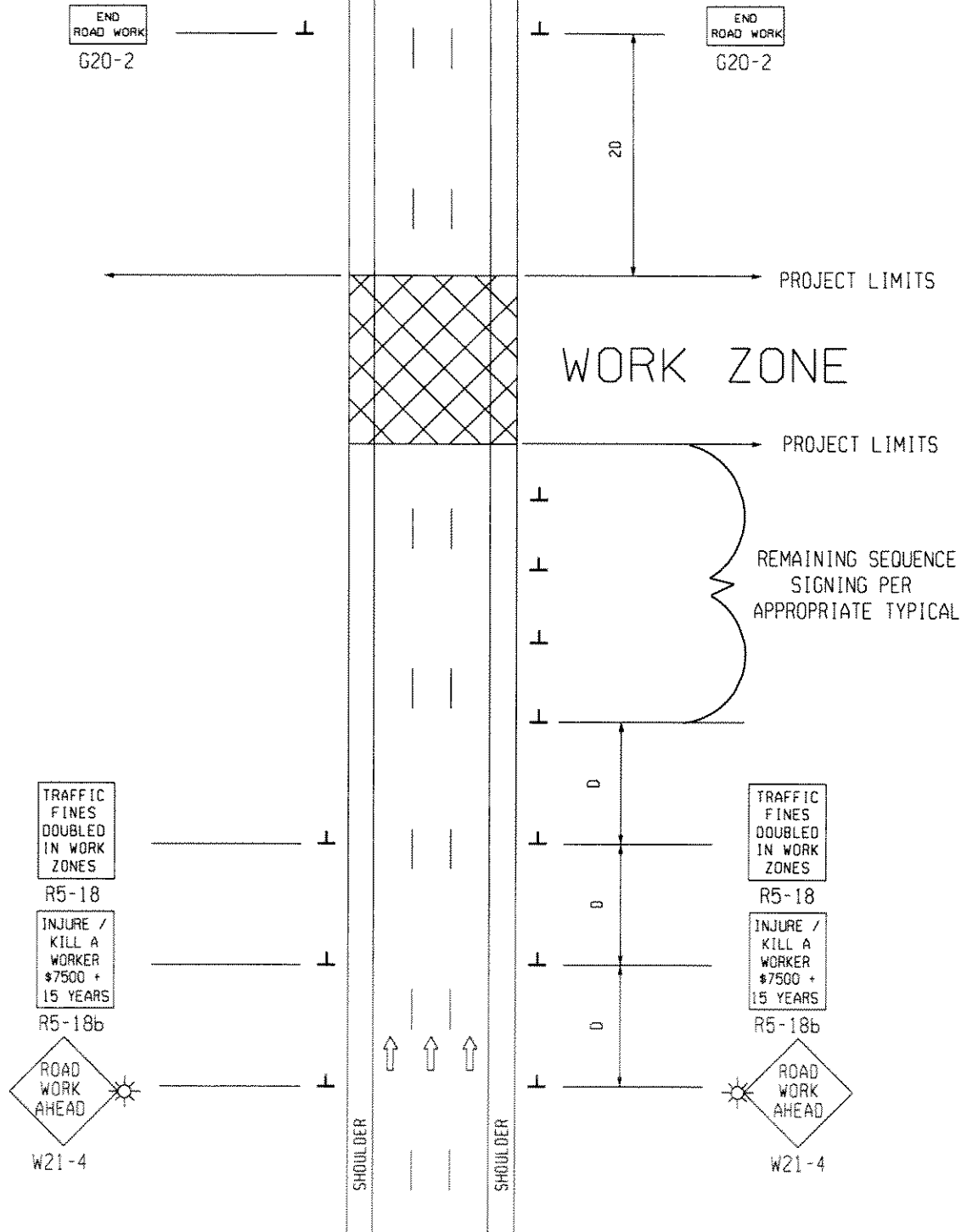
SPEED* MPH	LENGTH FEET
20	33
25	50
30	83
35	132
40	181
45	230
50	279
55	329
60	411
65	476
70	542

\* POSTED SPEED, OFF PEAK 85TH PERCENTILE SPEED PRIOR TO WORK STARTING, OR THE ANTICIPATED OPERATING SPEED

<sup>1</sup> BASED UPON AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) BRAKING DISTANCE PORTION OF STOPPING SIGHT DISTANCE FOR WET AND LEVEL PAVEMENTS (A POLICY ON GEOMETRIC DESIGN OF HIGHWAY AND STREETS), AASHTO. THIS AASHTO DOCUMENT ALSO RECOMMENDS ADJUSTMENTS FOR THE EFFECT OF GRADE ON STOPPING AND VARIATION FOR TRUCKS.

 Michigan Department of Transportation TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL		TABLES FOR "L", "D" AND "B" VALUES	
DRAWN BY: DFK	MARCH 2000	M000e	SHEET
CHECKED BY: BMM	PLAN DATE:		2 OF 2
FILE: K:/DGN/TSR/STD5/ENGLISH/MNTTRF/M000e.dgn		REV. Nov. 24, 2003	

SIGN PLACEMENT  
IS THE SAME FOR  
BOTH DIRECTIONS



SIGN = 192 ft<sup>2</sup> - TYPE B  
FOR BOTH DIRECTIONS OF TRAFFIC  
W21-4 QUANTITY INCLUDED WITH  
APPROPRIATE TYPICAL FOR  
SEQUENCE SIGNING

NOT TO SCALE

**MDOT**  
Michigan Department of Transportation  
TRAFFIC AND SAFETY  
MAINTAINING TRAFFIC  
TYPICAL

TYPICAL ADVANCE SIGNING TREATMENT FOR  
INTERMEDIATE AND SHORT TERM  
STATIONARY WORK ZONE OPERATIONS WHERE  
ALL TRAFFIC CONTROL DEVICES ARE  
REMOVED AT END OF EACH WORK DAY ON  
A DIVIDED ROADWAY

DRAWN BY: DFK  
CHECKED BY: BMM  
FILE: K:\DON-TSR-STDS-ENGLISH-MNTTRF-M001fe.dgn

Jan. 23, 2004  
PLAN DATE:

M001fe

SHEET  
1 OF 2

REV. Jan. 23, 2004




## NOTES

30. THE APPROPRIATE ADVANCE SIGNING SEQUENCE(S), (M001ae THROUGH M001fe) SHALL BE USED ON ALL PROJECTS.
35. THESE SIGNS ARE INTENDED TO BE USED WITHIN THE LIMITS OF THE TEMPORARY SEQUENCE SIGNING AS IS SHOWN ON 1 OF 2. THESE SIGNS ARE NOT TO BE INTERMINGLED WITH ANY OTHER TEMPORARY SEQUENCE SIGNING EXCEPT AS SHOWN.

## SIGN SIZES

G20-2	-	48" x 24"
R5-18	-	48" x 60"
R5-18b	-	48" x 60"
W21-4	-	48" x 48"

NOT TO SCALE

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL		TYPICAL ADVANCE SIGNING TREATMENT FOR INTERMEDIATE AND SHORT TERM STATIONARY WORK ZONE OPERATIONS WHERE ALL TRAFFIC CONTROL DEVICES ARE REMOVED AT END OF EACH WORK DAY ON A DIVIDED ROADWAY	
DRAWN BY: DFK		Jan. 23, 2004	
CHECKED BY: BMM		PLAN DATE:	
FILE: K:\DGN-TSR-STD5-ENGLISH-MNTTRF-M001fe.dgn		M001fe	SHEET 2 OF 2
		REV.	Jan. 23, 2004

## **Procedure for revision/ implementation on Work Zone Speed Limits for 2005**

Effective May 4, 2005, MDOT is required to be in substantial compliance with the following procedure:

Existing projects currently in place are required to be revised to meet the new speed limit requirements, meeting sign spacing requirements as shown in the sample traffic control typical. This will require resetting most advance work zone signing.

1. Roadways with an existing speed limit of 50 mph or higher must have posted work zone speed limits of 45 miles per hour where channelizing devices are used to separate the work area from the traffic area. This includes shoulder closures with channelizing devices.
2. For projects with a mixture of channelizing devices and barrier wall with workers behind the wall, but next to traffic, work zone speed limits shall be posted at 45 mph.
3. Speed limit reductions shall be in maximum increments of 10 mph. For freeways, this means speeds will go from 70/60/50/45.
4. For all other projects where existing speed limits are 45 mph or less, existing speed limit designs will follow current MDOT established practice and not be revised.
5. For projects where the motorist has been separated from construction by 30 feet or more, existing speed limit designs will follow current MDOT established practice and not be revised.
6. For long projects with multiple work areas, the following applies:
  - a.) Projects with less than 2 ½ miles from the last drum or cone in one work area to the first drum or cone in the next work area, the work areas are to be treated as one work zone and closed up with the appropriate channelizing devices. All conflicting signing shall be removed.
  - b.) Projects with more than 2 ½ miles from the last drum in one work area to the first drum in the next work area are to be treated as separate work zones and signed accordingly.
7. Work zone speed limits shall remain at 45 mph, even if there are no workers present.
8. Additional 45 mph speed limit signs shall be posted at one mile intervals throughout the project.
9. For speed limit reductions where no lanes are closed, a Traffic Control Order (TCO) is required to be submitted to establish a legal speed limit, which must be done prior to establishing the work zone. For any project that is being retrofit, submit a TCO as soon as possible to Leo Arens, Traffic and Safety, Lansing. A sample of the required TCO is attached.
10. All Maintenance operations meeting the above criteria with shoulder or lane closures with channelizing devices are also required to comply with these requirements.

## **Procedure for revision/ implementation on Work Zone Speed Limits for 2005**

### **Additional Requirements:**

1. Review work zones to make sure that all conflicting speed limits are covered, including truck speed limits.
2. Review channelizing device placement and provide for a reasonable lane width. When possible, reduce lane widths by placing channelizing devices closer to the traffic lane. This will provide for improved lateral offset for the worker and discourage the motorist from attempting passing in areas that could accommodate two vehicles side by side.
3. On projects with expedited schedules or lane rentals, consider revision of the speed limits in these areas first.
4. TSC/Region staff are required to track all complaints and increased costs for the work of revising the signing.
5. Samples of traffic control typicals are being provided to help guide staff and industry on the required changes. All existing typicals will not be revised at this time.
6. On new projects being developed for the 2005 season, include the required signing as part of the project. Use the sample typicals for sign layout or revise your existing typicals as necessary.
7. On projects where the sample typicals cannot apply, contact the following staff for additional guidance:

University, Bay and Metro Regions: Bruce Munroe - (517) 335-2856

Superior, North, Grand and Southwest Regions: Brian Zimmerman – (517) 242-7366

Bruce and Brian will provide backup for each other. If one is in the field or not available, please contact the other.

File:

**TRAFFIC CONTROL ORDER**

(Temporary)

SP-T

By virtue of the authority vested in the Michigan Transportation Commission by 1931 PA 328, MCLA 750.497, Section 497 of the Michigan Penal Code, we hereby order the maximum speed limit on state trunkline highway \_\_\_\_\_ in the city/twp of \_\_\_\_\_, County to be lowered as follows:

To a speed limit of forty-five (45) miles per hour in increments of no more than 10 miles per hour from a point one mile in advance of the (Describe POB) to the (Describe POE), and in the opposing direction from a point one mile in advance of the (Describe POE) to the (Describe POB).

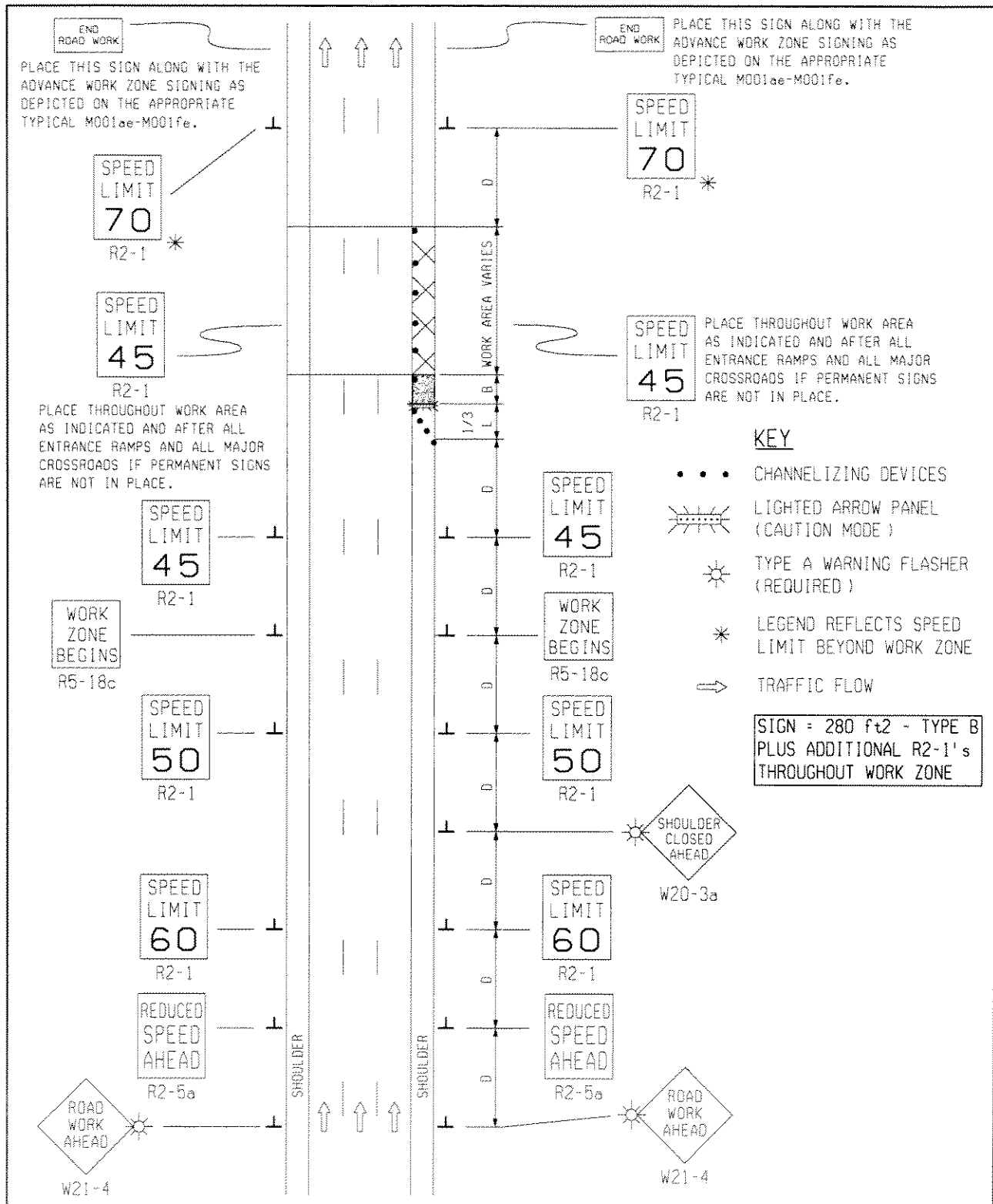
And, that all police agencies having jurisdiction therein shall enforce said regulation when official traffic control signs conforming to the mandate of this order have been erected.

This temporary traffic control order is effective from \_\_\_\_\_ through \_\_\_\_\_ and is necessary for safe and efficient movement of vehicular and pedestrian traffic during the \_\_\_\_\_.

MICHIGAN TRANSPORTATION  
COMMISSION

By: \_\_\_\_\_  
Director  
Michigan Department of Transportation

Date: \_\_\_\_\_



NOT TO SCALE

<p>Michigan Department of Transportation</p> <p>TRAFFIC AND SAFETY</p> <p>MAINTAINING TRAFFIC TYPICAL</p>		<p>TYPICAL TEMPORARY TRAFFIC CONTROL FOR A SHOULDER CLOSURE UP TO 1 MILE IN LENGTH ON A FREEWAY, MAXIMUM 25 MPH SPEED REDUCTION.</p>	
<p>DRAWN BY: DFK</p> <p>CHECKED BY: BMM</p>	<p>APRIL 2005</p> <p>PLAN DATE:</p>	<p>M898e</p>	<p>SHEET 1 OF 2</p>
<p>FILE: PW RD TS T Signs-Maintain Traffic-M898e.dgn REV. 4/21/2005</p>			


## NOTES

- 1E. D = DISTANCE BETWEEN TRAFFIC CONTROL DEVICES  
 $\frac{1}{3} L$  = MINIMUM LENGTH OF TAPER  
 B = LENGTH OF LONGITUDINAL BUFFER  
 SEE M000e FOR "D," "L," AND "B" VALUES
2. ALL NON-APPLICABLE SIGNING WITHIN THE CIA SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
- 3A. THE "WORK ZONE BEGINS" (R5-18c) SIGN SHALL BE USED ONLY IN THE INITIAL SIGNING SEQUENCE IN THE WORK ZONE. SUBSEQUENT SEQUENCES IN THE SAME WORK ZONE SHALL OMIT THIS SIGN AND THE QUANTITIES SHALL BE ADJUSTED APPROPRIATELY.
- 4E. THE MAXIMUM RECOMMENDED DISTANCE(S) BETWEEN CHANNELIZING DEVICES SHOULD BE EQUAL IN FEET TO THE POSTED SPEED IN MILES PER HOUR ON TAPER(S) AND TWICE THE POSTED SPEED IN THE PARALLEL AREA(S).
5. FOR OVERNIGHT CLOSURES, CHANNELIZING DEVICES SHALL BE LIGHTED PLASTIC DRUMS.
6. THE TYPE A WARNING FLASHER SHOWN ON THE WARNING SIGNS SHALL BE POSITIONED ON THE SIDE OF THE SIGN NEAREST THE ROADWAY.
7. ALL 4' x 4' WARNING SIGNS, TYPE III BARRICADES, THEIR TEMPORARY SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL BE FABRICATED IN ACCORDANCE WITH THE CURRENT STANDARD PLAN.
8. WHEN BUFFER AREAS ARE ESTABLISHED, THERE SHALL BE NO EQUIPMENT OR MATERIALS STORED OR WORK CONDUCTED IN THE BUFFER AREA.
- 16B. WHEN REDUCED SPEED LIMITS ARE UTILIZED IN THE WORK AREA, ADDITIONAL SPEED LIMIT SIGNS RETURNING TRAFFIC TO ITS NORMAL SPEED SHALL BE PLACED BEYOND THE LIMITS OF THE REDUCED SPEED AS INDICATED.
- 16D. ADDITIONAL SPEED LIMIT SIGNS REFLECTING THE REDUCED SPEED SHALL BE PLACED AFTER EACH ENTRANCE RAMP THAT COMES ONTO THE FREEWAY WHERE THE REDUCED SPEED IS IN EFFECT AND AT INTERVALS ALONG THE ROADWAY SUCH THAT NO SPEED LIMIT SIGNS REFLECTING THE REDUCED SPEED ARE MORE THAN ONE MILE APART.
- 16E. WHEN EXISTING SPEED LIMITS ARE REDUCED MORE THAN 10 MPH, THE SPEED LIMIT SHALL BE STEPPED DOWN IN MORE THAN 10 MPH INCREMENTS.

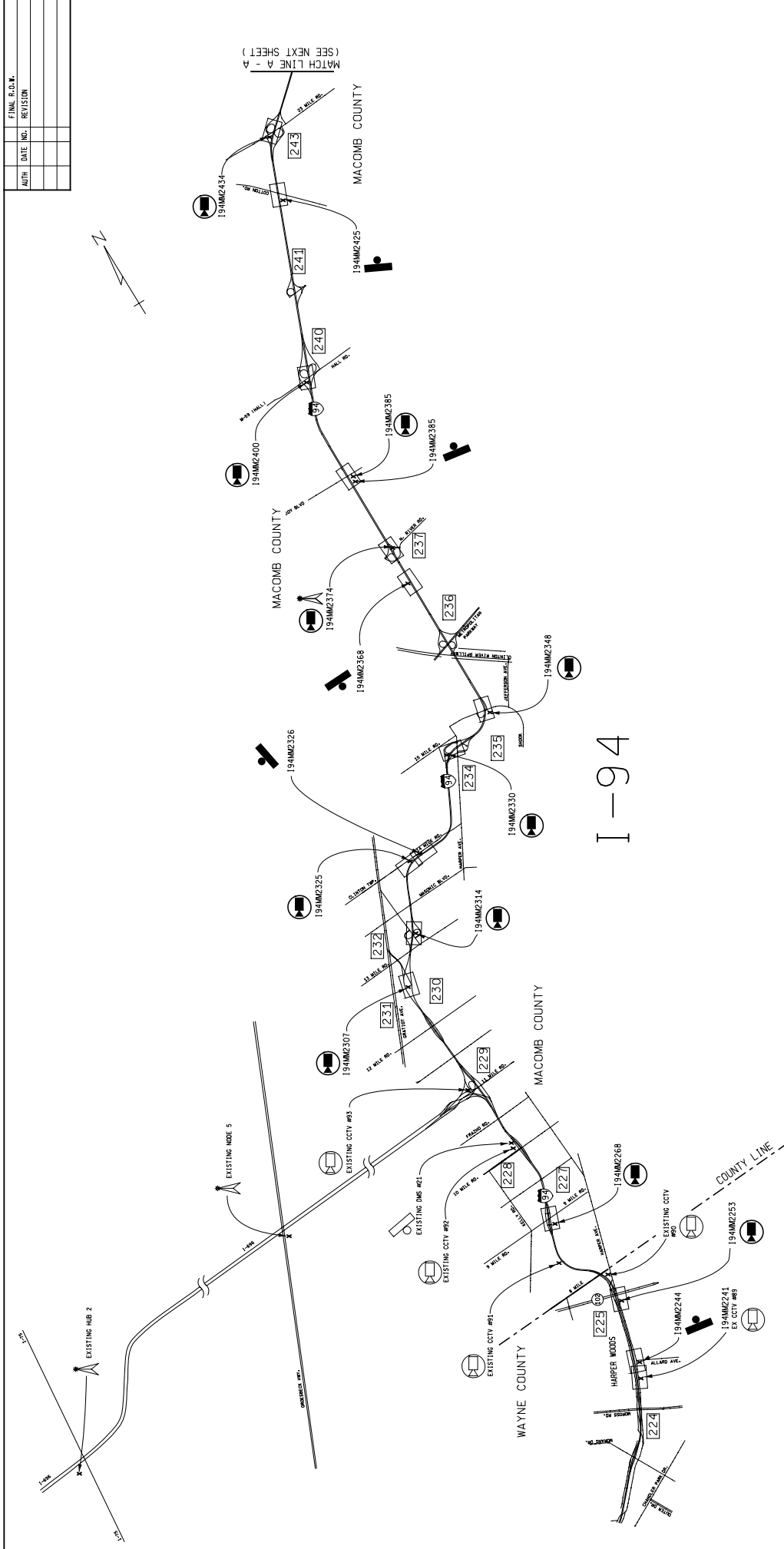
## SIGN SIZES

DIAMOND WARNING - 48" x 48"  
 RECTANGULAR REGULATORY - 48" x 60"  
 R5-18c REGULATORY - 48" x 48"


NOT TO SCALE

 Michigan Department of Transportation TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL		TYPICAL TEMPORARY TRAFFIC CONTROL FOR A SHOULDER CLOSURE UP TO 1 MILE IN LENGTH ON A FREEWAY, MAXIMUM 25 MPH SPEED REDUCTION.	
DRAWN BY: DFK	APRIL 2005	M898e	SHEET
CHECKED BY: BMM	PLAN DATE:		2 OF 2
FILE: PW RG TS T Signs-Maintain Traffic-M898e.dgn		REV.	4/21/2005





FOR INFORMATION ONLY

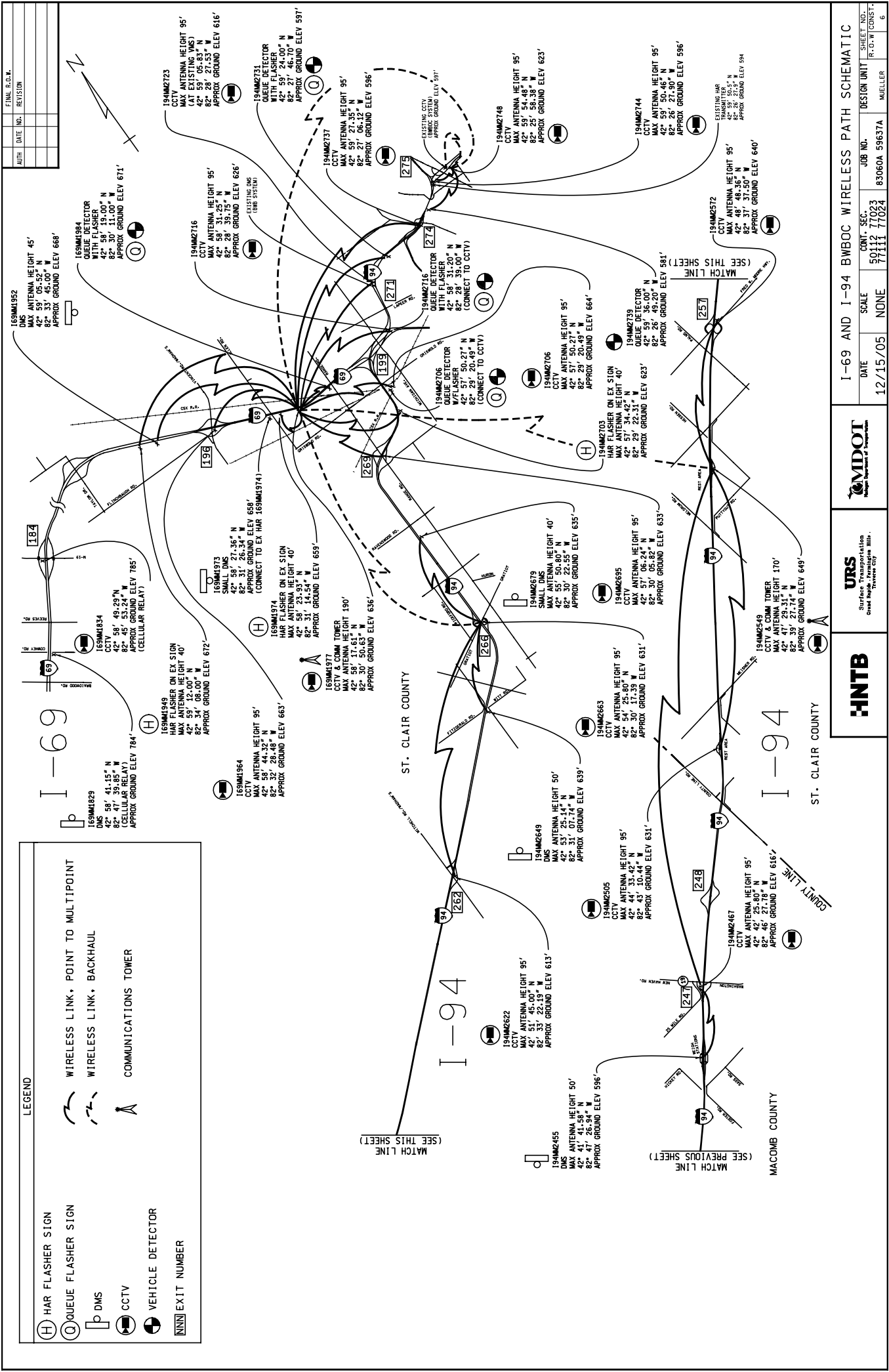
<b>HNTB</b>	<b>URS</b> Surface Transportation Grand Rapids / Ann Arbor Hills - Trenco City	 <b>MDOT</b> Michigan Department of Transportation	<b>VICINITY MAP</b>				
		DATE	SCALE	COUNT SEC.	JOB NO.	DESIGN UNIT	SHEET NO. R.C.D.# CONST #
		12/15/05	NONE	501.41	830600A		MUTTER











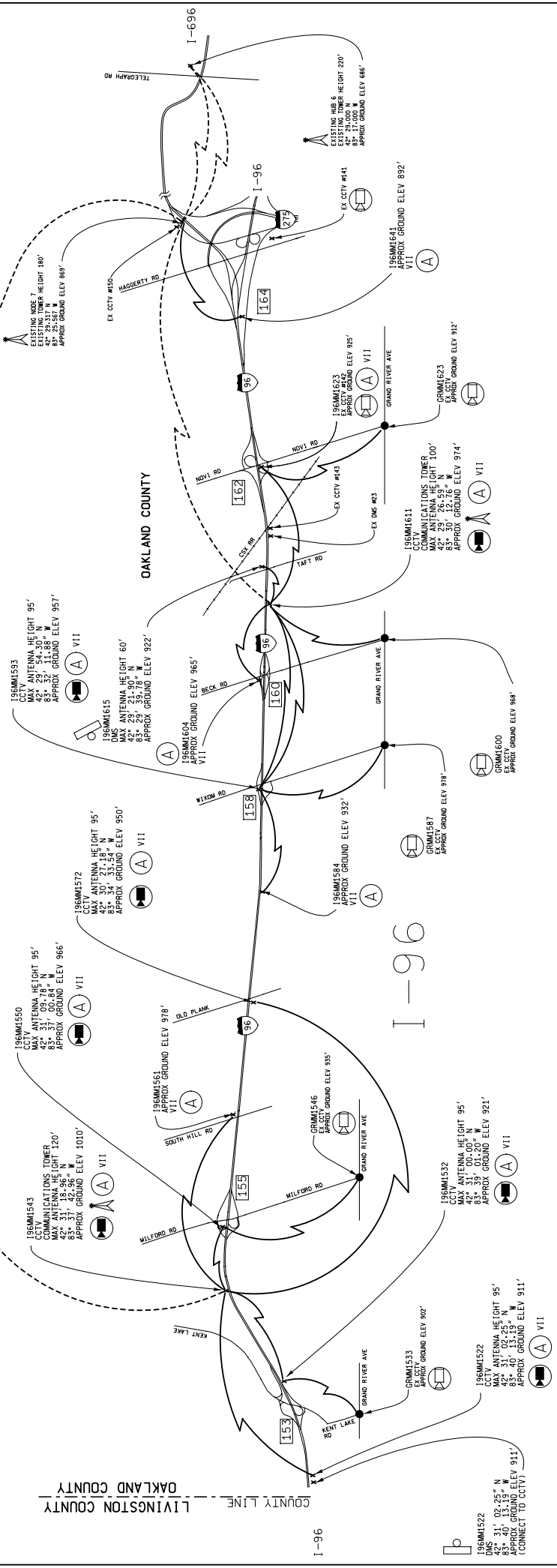
LEGEND	
	HAR FLASHER SIGN
	QUEUE FLASHER SIGN
	DMS
	CCTV
	VEHICLE DETECTOR
	EXIT NUMBER
	WIRELESS LINK, POINT TO MULTIPOINT
	WIRELESS LINK, BACKHAUL
	COMMUNICATIONS TOWER

I-69 AND I-94 BWDOC WIRELESS PATH SCHEMATIC	
DATE	12/15/05
SCALE	NONE
CONTRACT NO.	50142 77023
JOB NO.	83060A 59637A
DESIGN UNIT	83060A 59637A
SHEET NO.	6
PROJECT NO.	12/15/05
PROJECT NAME	I-69 AND I-94 BWDOC WIRELESS PATH SCHEMATIC
PROJECT LOCATION	ST. CLAIR COUNTY, MACOMB COUNTY, IONIA COUNTY
PROJECT OWNER	MACOMB COUNTY
PROJECT ENGINEER	URS
PROJECT ARCHITECT	URS
PROJECT CONSULTANT	URS
PROJECT SPECIALIST	URS
PROJECT SUBMITTER	URS
PROJECT REVIEWER	URS
PROJECT APPROVER	URS
PROJECT SIGNATURE	URS
PROJECT DATE	12/15/05
PROJECT LOCATION	ST. CLAIR COUNTY, MACOMB COUNTY, IONIA COUNTY
PROJECT OWNER	MACOMB COUNTY
PROJECT ENGINEER	URS
PROJECT ARCHITECT	URS
PROJECT CONSULTANT	URS
PROJECT SPECIALIST	URS
PROJECT SUBMITTER	URS
PROJECT REVIEWER	URS
PROJECT APPROVER	URS
PROJECT SIGNATURE	URS
PROJECT DATE	12/15/05

FINAL S.D.W.	DATE	NO.	REVISION



LIVINGSTON COUNTY  
OAKLAND COUNTY

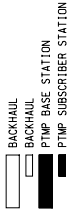


LEGEND	
(H) HAR FLASHER SIGN	(R) VII TEST BED WIRELESS ROUTER (FOR INFORMATION ONLY)
(Q) QUEUE FLASHER SIGN	(A) VII TEST BED ACCESS POINT (FOR INFORMATION ONLY)
(D) DMS	(W) WIRELESS LINK, POINT TO MULTIPPOINT
(C) CCTV	(W) WIRELESS LINK, BACKHAUL
(V) VEHICLE DETECTOR	(T) COMMUNICATIONS TOWER
(N) EXIT NUMBER	

I-96 MITSC WIRELESS PATH SCHEMATIC			
DATE	SCALE	CONT. SEC.	JOB NO.
12/15/05	NONE	63022	83057A/77009A
DESIGN UNIT		SHEET NO.	
MELLER		R.O.W. CONST.	
		7	

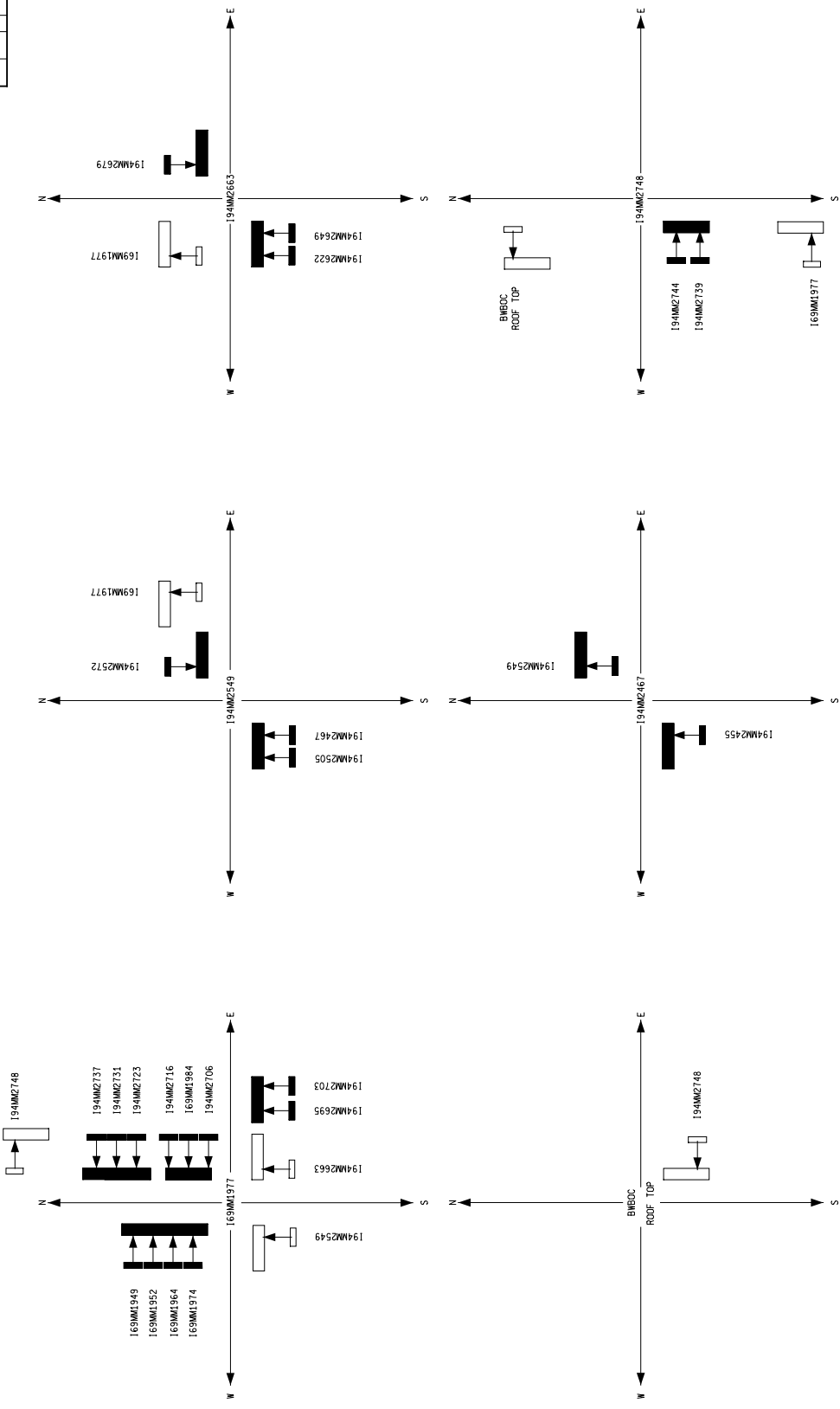






I-96, I-94 BWB

URS		INDOT		WIRELESS LINKS CARDINAL DIRECTION LAYOUT	
Surface Transportation and Transportation Trusts Trenton City		INDOT Indiana Department of Transportation		DESIGN UNIT	
DATE		SCALE		JOB NO.	
12/15/05		NONE		83060A 55637A	
CONTRACT NO.		CONTRACT NO.		CONTRACT NO.	
50122-117023		50122-117023		50122-117023	
55637A		55637A		55637A	
77009A		77009A		77009A	
DESIGNER		DESIGNER		DESIGNER	
MUELLER		MUELLER		MUELLER	
SHEET NO.		SHEET NO.		SHEET NO.	
9		9		9	

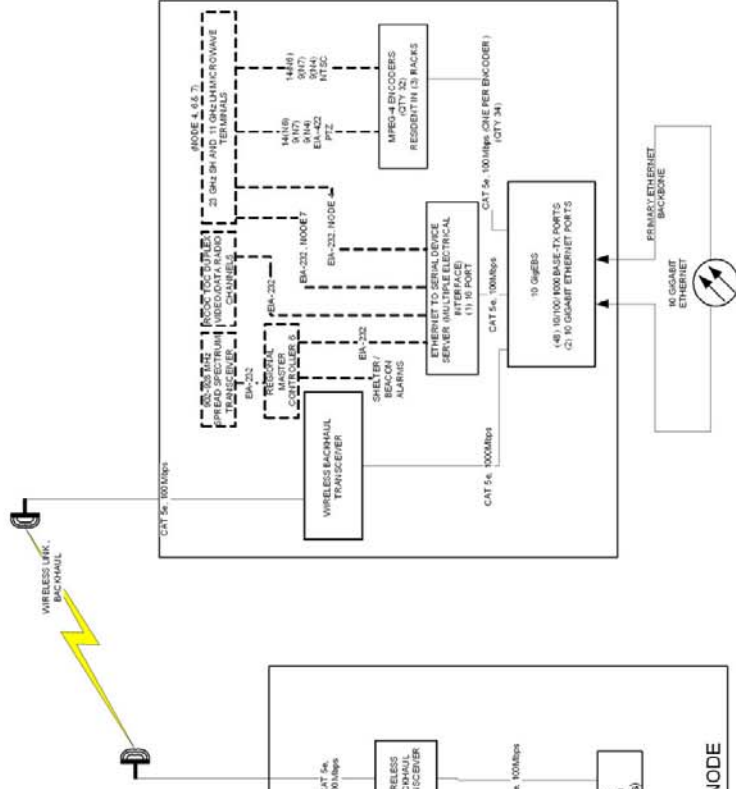


FINAL S.O.M.	DATE	NO.	REVISION





	AUTH	DATE	NO.	FINAL R.O.N.
				REVISION





**INTB**

**URS**

Surface Transportation  
Grand Rapids Airport  
1000 1st Avenue, S.W.  
Trenton, NJ 08611



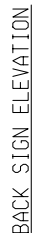
**VMDOT**  
Michigan Department of Transportation

## COMMUNICATION SYSTEM BLOCK DIAGRAM

DATE	SCALE	CONT. SEC.	JOB NO.	DESIGN UNIT	SHEET NO. R.O.W CONST.
12/15/05	NONE	62025 5011 50135 222 112023	83060A 59637A 83057A 77009A	MUELLER	15



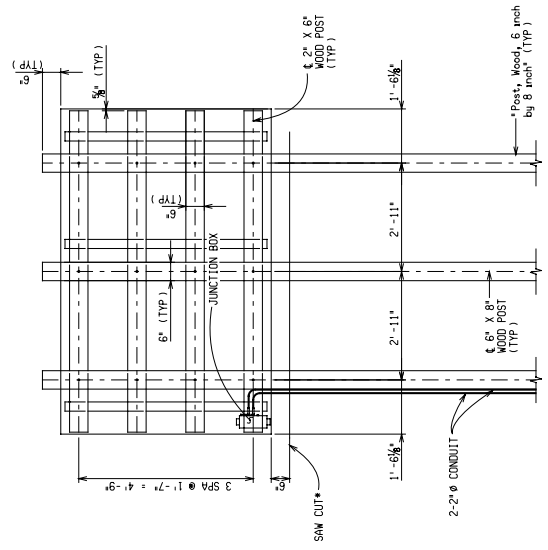
				FINAL R.O.N.
				REVISION



TYPICAL OF SITES:  
I94MM2679  
I69MM1973

SAW CUT SHALL BE PLACED ON APPROACH TRAFFIC SIDE OF POST. SAW CUT SHALL BE  $\frac{1}{4}$ " HIGH BY  $1\frac{1}{2}$ " DEEP.

SECTION A-A

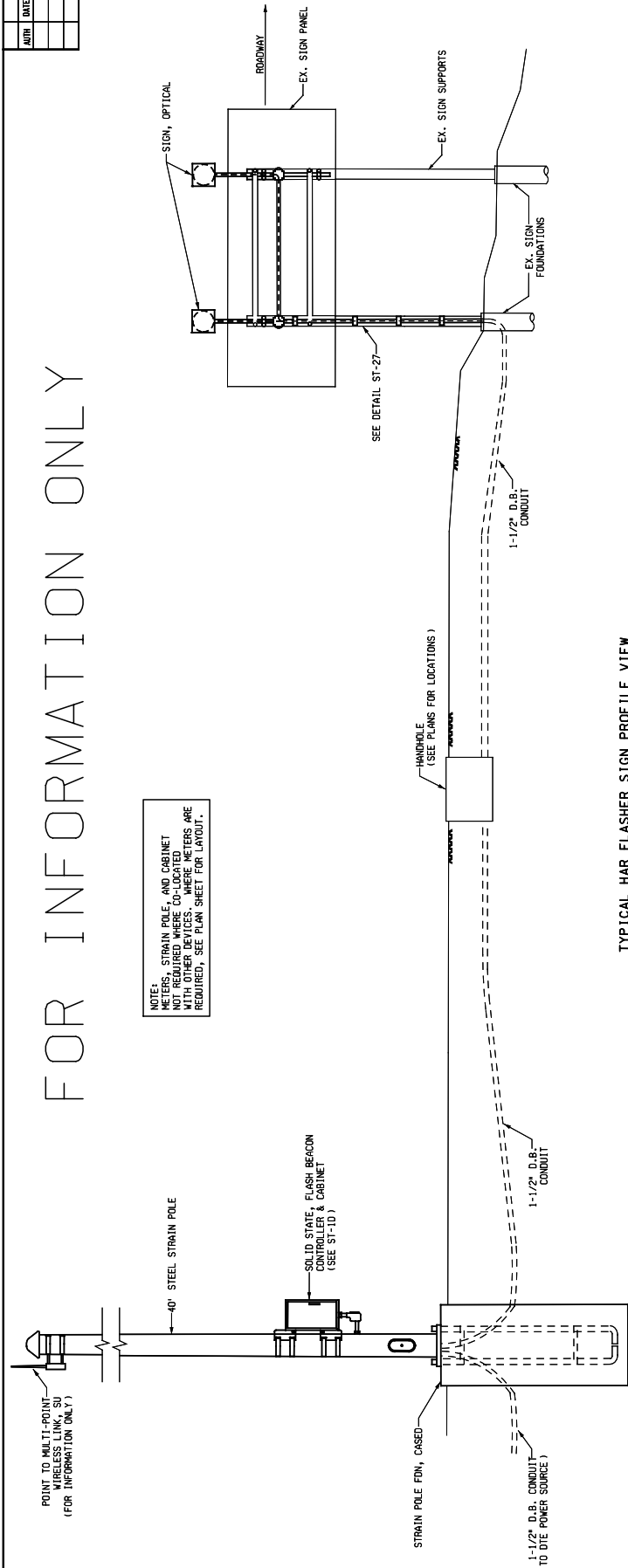


CONSTRUCTION SHEET

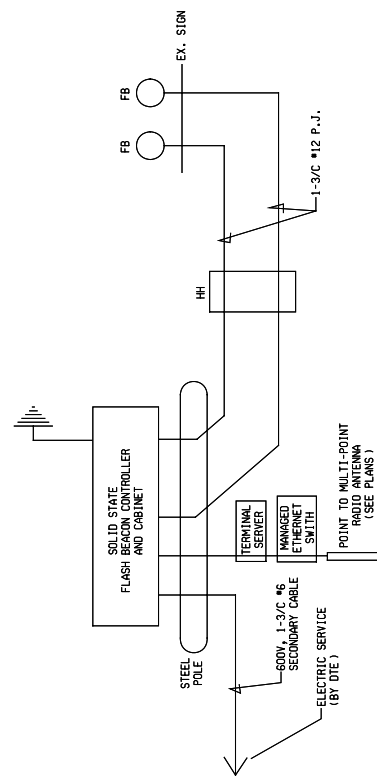
 <b>HNTB</b>	 <b>URS</b> Surface Transportation Grand Rapids, Fermentation Mills, Traverse City	 <b>MDOT</b> Michigan Department of Transportation	SMALL DMS DETAIL				
			DATE 12/15/05	SCALE NONE	CONT. SEC. 77111/77023	JOB NO. 59637A	DESIGN UNIT 83060A

FOR INFORMATION ONLY

DATE	NO.	REVISION



TYPICAL HAR FLASHER SIGN PROFILE VIEW  
NOT TO SCALE

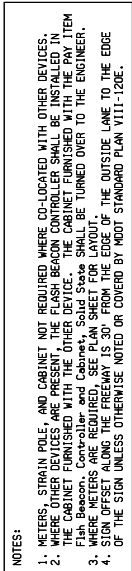


TYPICAL HAR FLASHER WIRING DIAGRAM  
NOT TO SCALE

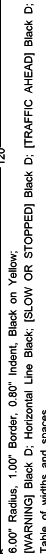
HAR 169MM1949, 169MM1974, & 194MM2703 DETAIL

FILE NAME: har 481011.dgn	CHECKED BY:	DATE:	WORKED ON BY:
HNTB			
URS Surface Transportation Consulting Engineers, Inc. Thousand Oaks, CA			
MDOT Michigan Department of Transportation			
FLASHER ON EXISTING HAR SIGN DETAIL			
DATE 12/15/05	SCALE NONE	CONT. SEC. 77023	JOB NO. 59637A
DESIGN UNIT MUELLER			SHEET NO. 108

	AUTH	DATE	NO.	FINAL R.O.W.
				REVISION

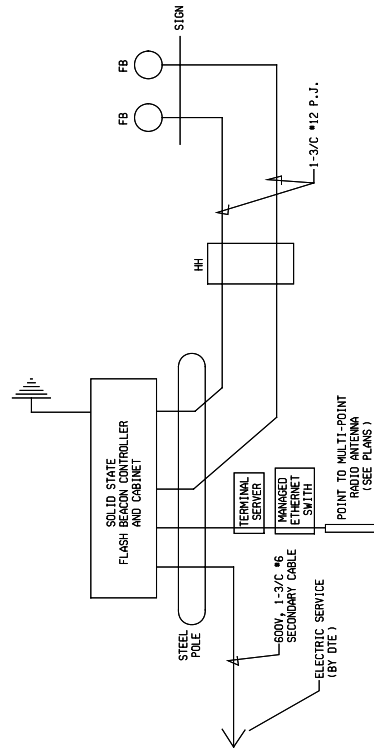


TYPICAL QUEUE DETECTOR FLASHER SIGN PROFILE VIEW  
NOT TO SCALE






	W	A	R	N	I	N	G
31.3	8.7	0.7	8.3	1.9	6.7	2.4	6.7
17	—	116	17				

	S	L	O	W	O	R	S	T	O	P	E	D	
107	82.54	18.49	15.56	15.70	80.57	18.54	80.54	15.49	15.56	19.53	19.54	18.54	82
108	172.49	15.54	15.67	15.48	15.49	15.13	18.54	80.67	15.54	18.49	10.67	15.54	172



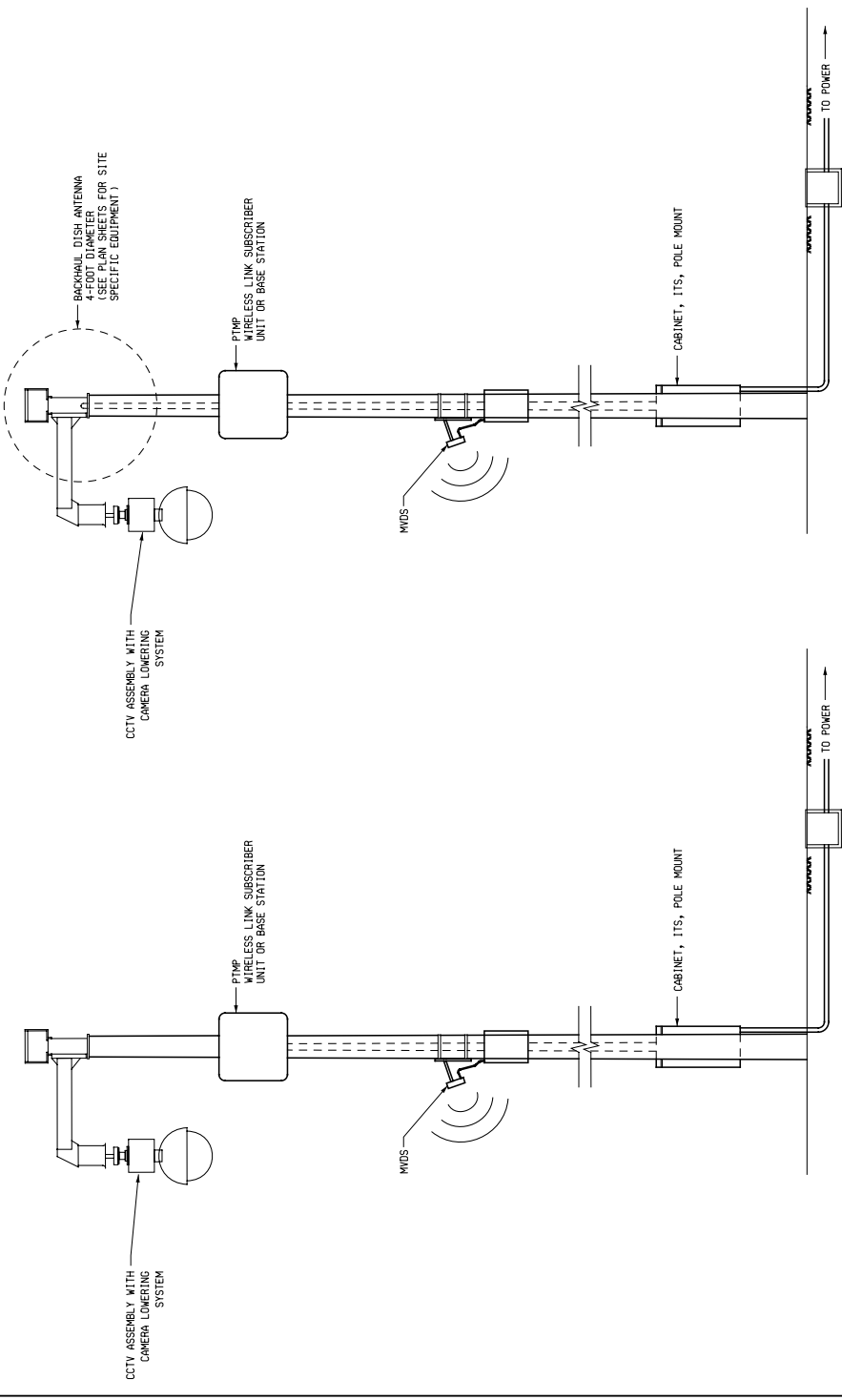
**TYPICAL QUEUE DETECTOR FLASHER WIRING DIAGRAM**  
NOT TO SCALE

I94MM2706, I94MM2716, I94MM2731, I69MM1984

 <b>HNTB</b>	 <b>URS</b> Surface Transportation Grand Rapids, Farmington Hills, Troy, MI	 <b>MWDOT</b> Michigan Department of Transportation	QUEUE DETECTOR FLASHER ON SIGN DETAIL					
			DATE 12/15/05	SCALE NONE	CONT. SEC. 77023	JOB NO. 596374	DESIGN UNIT MUEI/FB	SHEET NO. R-0-W CONSTR. 1 OF 1

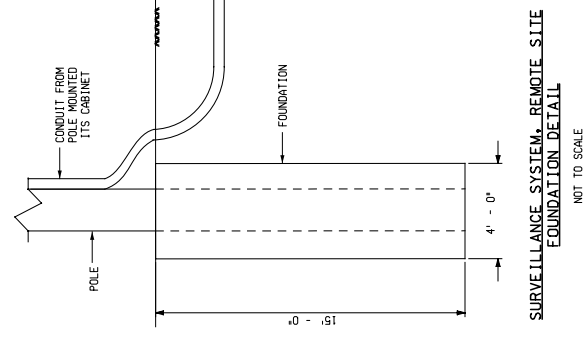
DATE	NO.	REVISION

DATE	NO.	REVISION



**SURVEILLANCE SYSTEM, REMOTE SITE  
WITH PTMP WIRELESS LINK**  
NOT TO SCALE

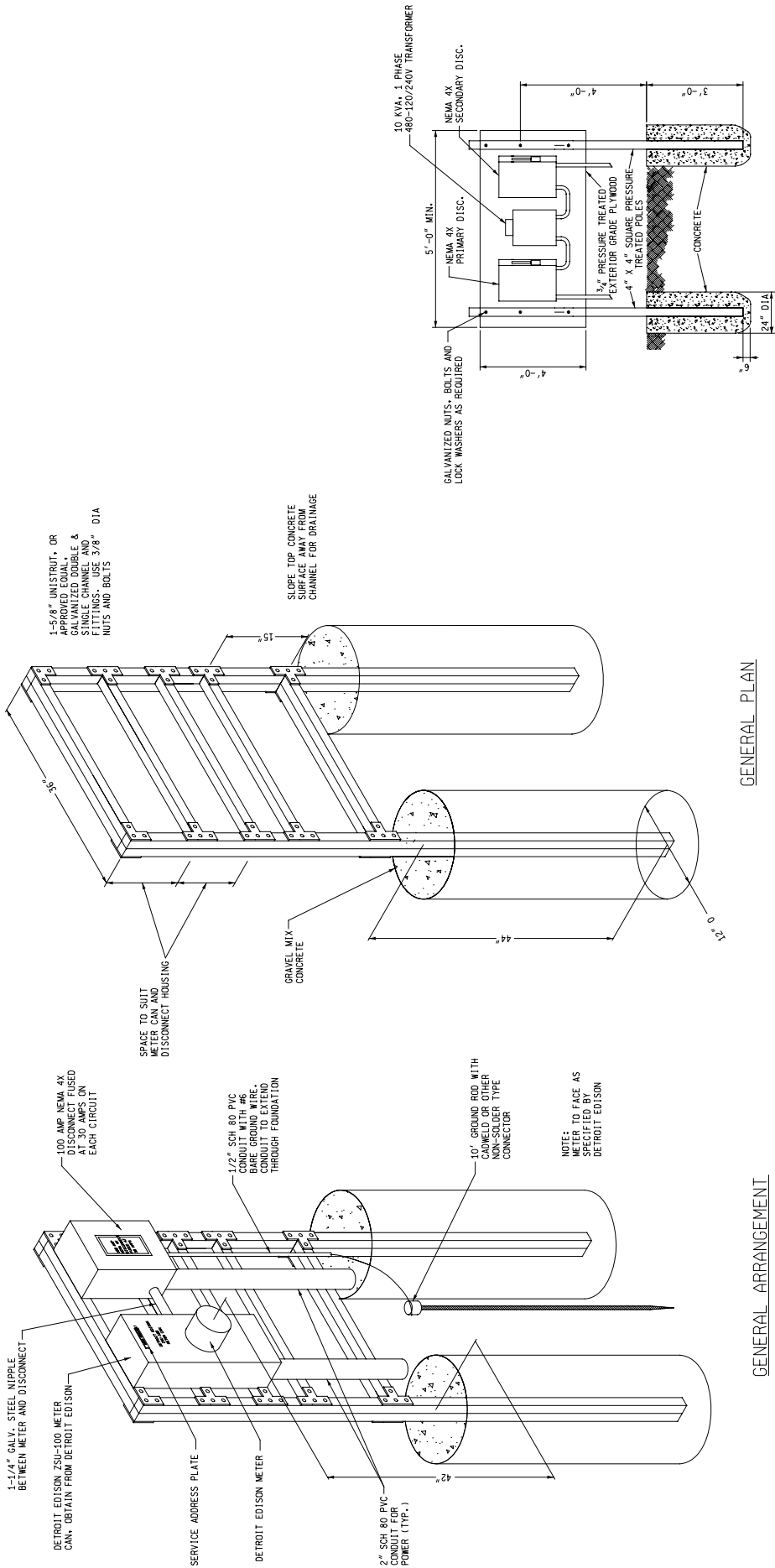
**SURVEILLANCE SYSTEM, REMOTE SITE  
WITH BACKHAUL WIRELESS LINK**  
NOT TO SCALE



<div><div>INTB</div><div>Surface Transportation Grand Rapids, Kalamazoo Mills, Troyes City</div></div>		<div><div>URS</div><div>Surface Transportation Grand Rapids, Kalamazoo Mills, Troyes City</div></div>	<div><div><div>Michigan Department of Transportation</div></div></div>	SURVEILLANCE SYSTEM, REMOTE SITE DETAIL					
				DATE	SCALE	CONT. SEC.	JOB NO.	DESIGN UNIT	SHEET NO.
				12/15/05	NONE	83060A 59637A 50127.111 77023 83027 77024	83060A 59637A 83057A 77009A	R.C.W. CONST.	110

FOR INFORMATION ONLY

AUTH	DATE	NO.	FINAL S.O.M.
			REVISION



GENERAL ARRANGEMENT  
POSITION OF THE METER & DISCONNECT  
MAY BE INTERCHANGED

GENERAL PLAN

TRANSFORMER DETAILS

NOT TO SCALE

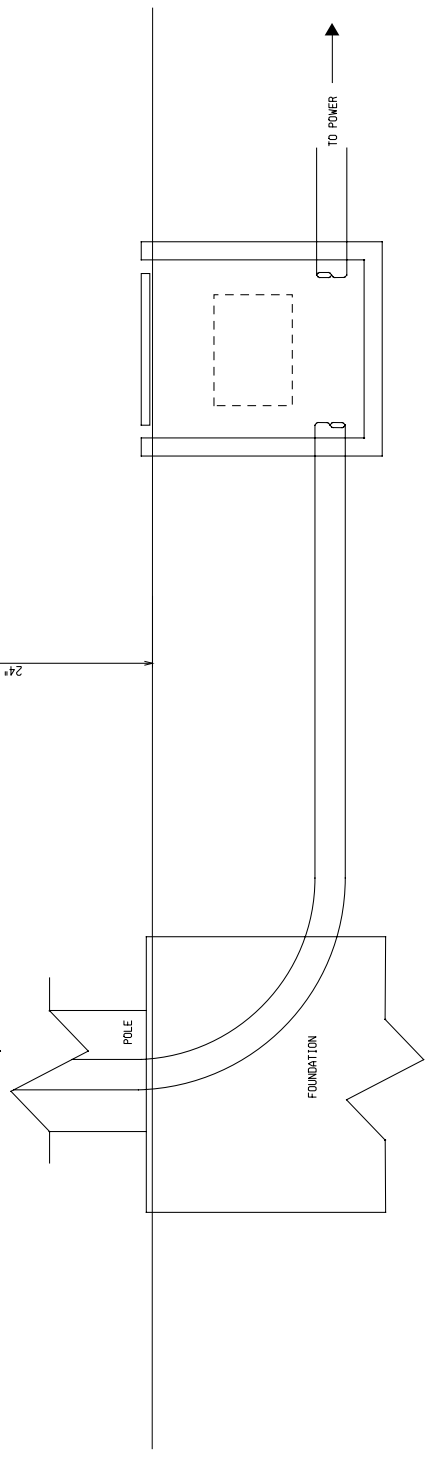
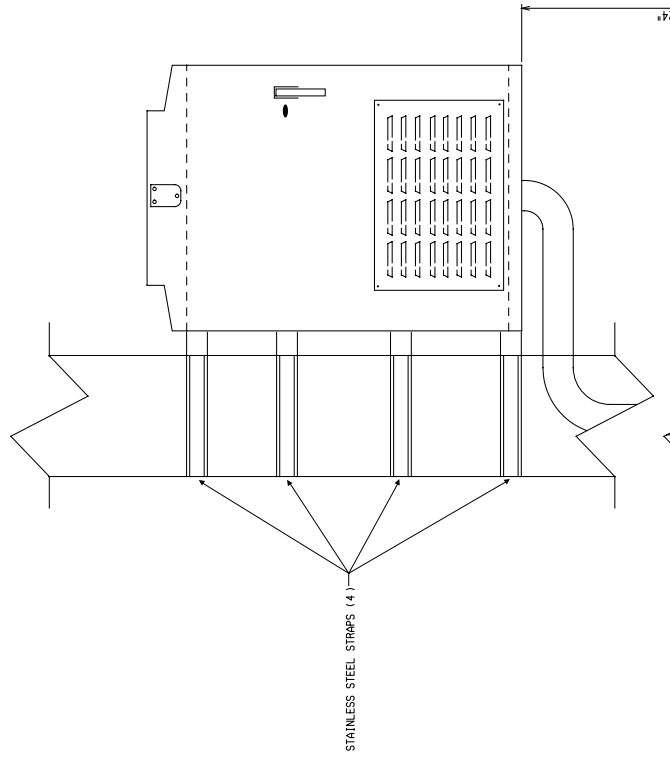
TYPICAL METER & SERVICE DISCONNECT RACK

ALL WORK TO CONFORM TO DETROIT EDISON REQUIREMENTS, INCLUDING  
DTE STANDARD 3-4-6, LATEST VERSION

NOTE:  
ALL MATERIALS, EQUIPMENT, AND LABOR ASSOCIATED WITH THE CONSTRUCTION OF THE WORK  
ON THIS SHEET SHALL BE INCLUDED IN THE PAY ITEM: Meter and Service Disconnect, ITS

NOT TO SCALE

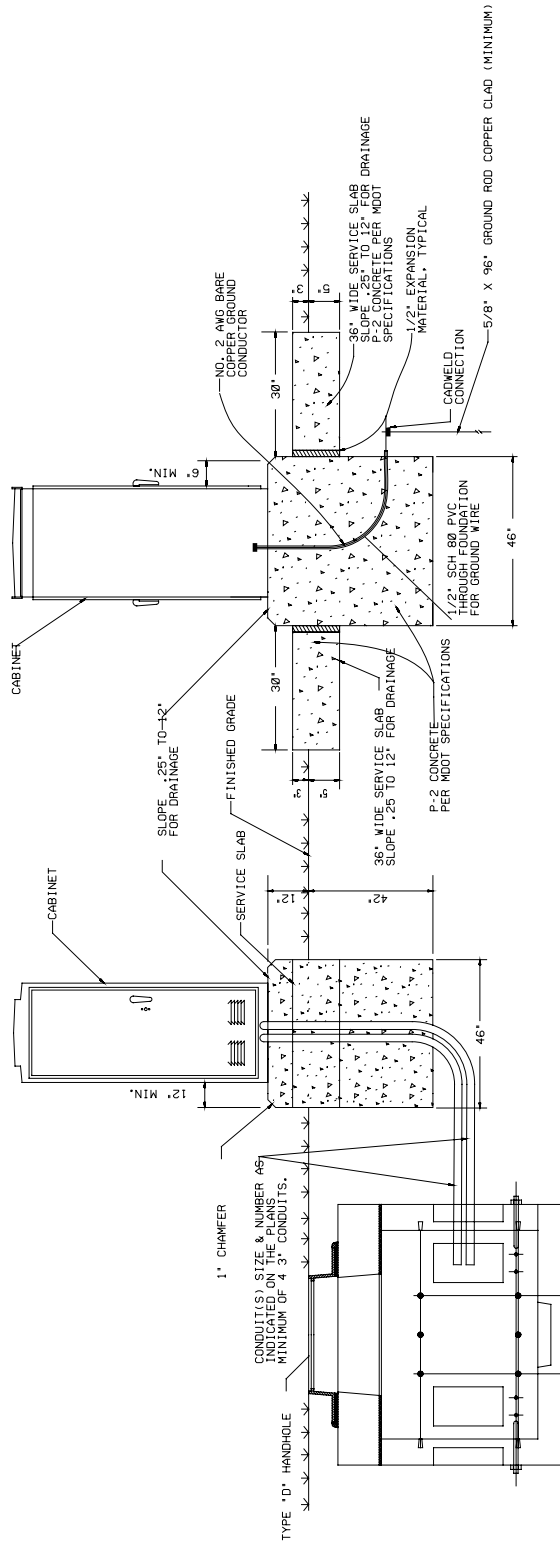
<div><div>INTB</div><div>Surface Transportation Grand Rapids, Michigan Mills - Traverse City</div></div>	<div><div>URS</div><div>Michigan Department of Transportation</div></div>	ELECTRICAL SERVICE DETAILS								
		DATE	SCALE	CONT. SEC.		JOB NO.	DESIGN UNIT			
				82025	50111			50112	77111	
		12/15/05	NONE	77024	77023	63022	83057A	77009A	MELLER	111



### TYPICAL POLE MOUNT ITS CABINET CONFIGURATION

<div>HNTB</div>		<div>URS</div> <div>Surface Transportation Grand Rapids, Permacore Hills, Traverse City</div>	<div> Michigan Department of Transportation</div>	ITS CABINET DETAIL					
				DATE	SCALE	CONF. SEC.	JOB NO.	DESIGN UNIT	SHEET NO.
				12/15/05	NONE	82025 5011 9012 7711 77023 53922 77024	830604 59637A 830574 77009A	MUELLER	R.G.W CONST. 112





ITS EQUIPMENT CABINET FOUNDATION

NTS

## NOTES:

1. THE LENGTH OF THE GROUND ROD ASSUMED FOR EACH EXISTING (ONG. C) CABLES CONTROLLER CABINET AND POST MOUNTED ELECTRICAL POWER SUPPLY TELEPHONE SERVICE ASSEMBLY SHALL BE NO SHORTER THAN THE MINIMUM LENGTH TO OBTAIN A MAXIMUM VALUE OF 10 OHMS OF RESISTANCE TO GROUND. IF NECESSARY, ADDITIONAL GROUND RODS SHALL BE INSTALLED TO OBTAIN THE MAXIMUM VALUE OF 10 OHMS.
2. MATERIAL REMOVED MAY BE USED FOR CONDUIT BACKFILL OR SPREAD EVENLY OVER EXISTING SLOPE. NO ADDITIONAL PAYMENT SHALL BE MADE FOR REMOVAL OF MATERIAL OFF SITE.
3. CABINET TO BE MOUNTED USING \*\* STAINLESS STEEL DROP IN INSERTS AND HIGH STRENGTH STAINLESS STEEL WASHERS AND BOLTS.
4. \*\* DIA STAINLESS STEEL BOLTS AND STAINLESS STEEL DROP-IN ANCHORS TO MOUNT CABINET TO FOUNDATION SHALL BE PROVIDED BY THE CONTRACTOR
5. CONDUITS TO BE LOCATED IN THE CENTER OF THE OPENING IN THE BOTTOM OF THE CABINET. A CONDUIT SHALL BE COVERED BY THE BASE OF THE CABINET. ALL CONDUITS SHALL FIT INSIDE A 13" DIAMETER CIRCLE, CENTERED ON THE CABINET FOUNDATION.
6. PROVIDE A MINIMUM OF FOUR 3" INCH DIRECT BURIAL CONDUITS BETWEEN THE HANDHOLE AND THE CABINET FOUNDATION. PROVIDE MORE CONDUITS IF CALLED FOR ON THE PLANS.

	 Surface Transportation Grand Rapids - Farmington Hills - Troy - Westland	 Michigan Department of Transportation	MITS ITS CABINET FOUNDATION				
			DATE 12/15/05	SCALE 1" = 50'	CONT. SEC. 77023	JOB NO. 59637A	DESIGN UNIT MUELLER